The
Tropical Agriculturist
June, 1927.

Editorial.

Tea Tortrix.

THIS number of the *Tropical Agriculturist* contains a resumé of data concerning the above pest of tea brought together in an article written by the Entomologist of the Tea Research Institue. In the Year Book of the Department of Agriculture for 1927, the results of investigations made during the past twelve months by the Government Entomologist on the above pest were also given. Control measures have been fully discussed and it is considered by both investigators that collection of egg-masses, caterpillars and pupae should form part of a programme for concerted action by all estates in districts where Tea Tortrix is known to be a pest.

It is however necessary if these measures of control are to be effective that they should be unanimously agreed upon by all affected estates and that they should be given a thorough and continuous trial for a period of at least three years.

It has been suggested in some quarters that legislation should be introduced to make this continuous collection of egg-masses, larvae and pupae compulsory, and that the requisite number of inspectors should be appointed to check and control the work.

It is possible that this aspect will be discussed at a forthcoming meeting of the Planters' Association, but no legislative enactments would make the campaign of egg-mass collection a success unless all associated with estates were convinced that the method proposed would give the required results and were prepared to sacrifice other works where necessary in order to be certain that no check in the egg-collecting campaign occurred. It would be perfectly useless if certain estates entered into the proposed campaign half-heartedly and did not utilize the maximum amount of labour necessary for the collections. If estates are prepared to give the proposals of egg-collection a complete and fair trial, the scheme can be put in operation just as effectively without legislation, and this is a matter which should receive careful consideration.

The collection of egg-masses is capable of improving the situation but it cannot be looked upon as an efficient measure. Further methods of control must be devised if any permanent reduction in the amount of tea tortrix is to take place. Opinions differ as to the prevalence of the pest but the concensus of opinion is that the pest in the Maskeliya district is no worse than it was several years ago, but that it has extended its range of attack. It is also now found in areas where it did not occur several years previously.

The most permanent method of control is likely to be found in parasites and the question of the introduction of parasites for this pest is worthy of close investigation. The Imperial Bureau of Entomology has recently been granted funds for special work with parasites of pests of economic crops and their assistance should be secured. It may be necessary for an Entomologist to visit several countries before the introduction of satisfactory parasites will be attained. In the meantime egg-mass collection should go on and it is hoped that affected estates will agree to combine in the Scheme now being formulated.

Original Articles.

A Review of the Present Situation Regarding Tea Tortrix in Ceylon.

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THE problem that is presented by the Tea Tortrix of Ceylon is, in the present state of our knowledge, one of the most elusive nature. Although Tortrix does not offer so formidable a menace to the tea industry as do the termites that are causing such damage in various parts of the island, it must, nevertheless, be classed as one of the chief pests that the tea planter is called upon to face.

It appears that this year (1926), more than ever, Tortrix has made its presence felt in the tea-growing districts which it usually frequents; Maskeliya, especially, has suffered so universally that scarcely an estate in that district has remained untouched.

One aspect of its attack is especially worthy of note. In the earlier days of this pest, when it first commenced its ravages in Maskeliya, sharp outbreaks occurred in restricted areas; one portion only of an estate would suffer severely, while the rest remained almost untouched. More recently, on the other hand, (I am informed), its tendency has been to produce a milder attack spread over the whole estate (although this year, the attacks have been both wide-spread and severe). It is this tendency that makes the problem of control so much more difficult, for whereas a concentrated attack may, by several different means, be readily subdued without a great deal of difficulty, an attack that is spread over a large area cannot be entirely controlled without considerable demands on labour and supervision.

The mode of infection of estates by the Tortrix moth is certainly a feature of the greatest importance, involving, as it does, the factors of natural habitat, distribution and manner of migration of the moth.

As regards the distribution, it appears from experience that Maskeliya is the chief breeding centre of Tortrix, and there seems little doubt that with the S.W. monsoon the moths migrate in a general North-Easterly direction, infecting Hatton, Dikoya and Dimbula. These districts constitute the main infested areas,

but at the same time, occasional flights of Tortrix are experienced in outlying regions, such as Nanu-oya and Badulla in the N.E.. and Ratnapura in the S.W. It is generally understood that the migration commences at Adam's Peak and follows a definite line in the direction indicated above. But from observation by the writer and others, it seems likely that a great part of the high jungle bounding Maskeliya on the Western side acts as a regular breeding-ground of the moth, as, perhaps, do some of the smaller jungle areas that occur at random in the infested districts.

Supposing this to be the case, it is obvious, at the start, that the idea of altogether exterminating Tortrix is at present out of the question. All that can be done now is to apply measures that will reduce the damage in the infested areas, and protect them as far as possible from the ravages of this pest.

During the last two years, much discussion has arisen regarding the various methods that have been suggested and adopted by planters for the control of this insect. It may at once be said that almost every method put forward has its justification to a certain extent and in certain circumstances, but the mistake has frequently been made of generalising a suggestion that is applicable only to a particular case. It now appears advisable to collect these different suggestions and to review briefly their respective merits and failings, with a view to discovering, if possible, those that show the greatest promise of success in the object for which they were designed.

Provisionally, these suggestions may be divided into two groups:—(1) " Active,"—where the carrying-out of some definite and repeated action is involved. The majority belong to this group.

(2) " Passive,"—where advantage is taken of some natural feature tending to the control of the pest, without necessitating much active co-operation on the part of the planter.

The following comprise the " Active " group:—

Egg-Mass Collecting.—This method consists of the collection of all leaves bearing egg-masses, and also embraces, usually, the squashing by hand of attacked and rolled-up leaves, with the object of destroying the caterpillars that are lodged within.

The collection of egg-masses is a mode of control that has for long been practised in entomology (especially in the earlier years, when the science was yet undeveloped), in cases where, owing to the nature of the crop, or to other adverse conditions, remedies such as spraying were impracticable. In the case of Tortrix, egg-mass collecting was one of the first methods to be advocated for the control of this insect after its recording as a pest of tea by E. E. Green in 1889. From that period to the present time, egg collecting has been more generally followed than any other single measure adopted.

Undoubtedly, one of the strongest arguments in favour of this method is its simplicity of execution. It requires little experience to enable one to " spot " an egg-mass, and the act of picking off the leaves and squashing the caterpillars is one that can readily be performed by the average estate coolie. Most people are ready to admit that egg collecting is an easy matter in the case of the milder outbreaks, for, as has often been pointed out, if the work prove too much for the usual coolie gangs to combine with their normal plucking, the children can be turned on at a small cost per head, and they should have little difficulty in coping with the extra work.

The chief arguments against this method are, (1) inability of coolies to recognise and remove the egg-masses, (2) cost, and (3) lack of labour.

Dealing with (1) first,—it is true that frequently leaves are brought in bearing egg-masses that have already hatched (and are therefore useless economically), or that bear no egg-mass at all, but with a little experience and regular training, and payment only for true egg-mass leaves, it should not be a difficult matter to overcome this trouble. In this connection, however, it is necessary to mention the difficulty that may sometimes be experienced by anyone in spotting egg-masses when the bushes are near to pruning and are well covered with foliage. This fact may cause the pluckers to pass over a certain number of masses which will remain as a source of later infection. It has been suggested that collecting should be carried out only on bushes 5-6 months from pruning, which are then in a condition when the egg-masses can be readily observed. But to collect only at such times would be useless, for this would mean that attacks on later bushes would remain unheeded, and for eighteen months (or longer, in a three-year pruning cycle) the pest would be allowed to develop unchecked.

Another fact that must be borne in mind while considering egg-mass collecting is that Tortrix possesses a wide range of different food-plants growing amidst and around the tea; the number of these plants is steadily increasing, and on some of them it breeds quite readily. This increase may be illustrated by the fact that in a short Maskeliya tour the writer was able to nearly double the number of food-plants already recorded.

More serious are the questions of labour and cost. The expense incurred in dealing with mild attacks, by making egg-mass collecting a part of the estate routine, should be, if properly conducted, almost negligible. But when really serious outbreaks occur, a considerable demand is usually made on extra labour, involving additional cost; account must be taken, too, of the call for supervision in counting and weighing the leaves, and in pay-

ment for work done in egg-collecting. Actually, however, the important question here is, not " What is the total cost of egg-collecting?," but " Is the cost involved covered by the saving in yield of leaf?" This question it is impossible to answer definitely, for few records have been compiled from this standpoint, and none affords any conclusive evidence. The difficulty of supplying such proof will be obvious to any one with experience in tea planting. This lack of proof, however, extends almost equally to all the remedies that have been suggested, and must not be regarded as a derogatory feature of the methods to which it applies.

The discussion of egg-mass collecting will be resumed further on.

Light Traps.—Placing out, amidst the fields, lamps or other sources of illumination, with the intention of attracting the moths.

This principle is also one which was early advocated against Tortrix, but has now, I believe, been entirely abandoned.

The trap itself usually consisted of a kerosene or acetylene lamp, sometimes provided with a pan containing water and kerosene beneath, so that the moths, in fluttering around, fell into the liquid and were destroyed. Fires have even been utilised as sources of light. Tortrix, being a night loving insect, flies readily to these traps, and by this means large numbers have been captured. At the same time, many moths have been labelled as Tortrix that were quite distinct species. The sex of the captured moths is an important item, for only fertilised females are of value in this respect. One of the chief objections to this method is the liability of attracting not only the local moths, but also others from adjoining estates. The fact that operations have to be conducted at night is, also, a difficulty as regards supervision; again, only still, dark nights are really suitable for the purpose, since the moths fly little by moonlight.

For these reasons the use of light traps is not to be recommended as a control measure.

Grevillea Leaves.—It was early discovered that dry Grevillea leaves have a special attraction for Tortrix moths, and this was adapted to the controlling of the pest. Sticks or poles were erected among the tea, about 30 or 40 feet apart. At the top of each was attached a bunch of dry leaves or branches of Grevillea. In these the moths collected at night, presumably to shelter from the falling dew; early each morning, before the dew dispersed, coolies went round with " cooty " sacks, with which they enveloped the leaves, and destroyed the moths within by pressure of the hands or by beating the sacks on the ground.

In earlier days this method was followed by many planters, and large numbers of moths were often attracted and destroyed. A strong objection, however, is that the collecting of the moths must be done entirely in the early morning, so that large areas cannot be dealt with effectively. The practice has, therefore, been discontinued.

Stripping the Bushes.—This method consists of stripping off all the buds and flush at the first sign of an attack, so as to catch and demolish the young caterpillars, which are yet on the tender shoots. By the removal of the youngest leaves, which alone are suitable for the development of the recently-hatched caterpillars, the latter are unable to spin up a shelter in which to feed, and thus perish: such is the principle of this method. Finally, the flush is either added to the other leaf in the baskets, or is put aside and burned; this latter process, however, seems unnecessarily wasteful, except where the attack is localised in a small area.

For mild attacks and those concentrated in small areas, stripping would certainly appear to be a useful measure, and outbreaks might frequently be stemmed by prompt action. But the caterpillars develop and increase so rapidly that, in severe or widespread attacks, I do not believe that this method is capable of coping with them.

Chemical Treatment.—Little use has been made of insecticides for the purpose of destroying or deterring the Tortrix larvae, due largely, no doubt, to a natural reluctance to apply any chemical substance to the actual foliage of the bush, for fear of tainting the manufactured tea.

For the control of leaf-eating caterpillars of the size of the Tortrix larvae, a substance is employed, dusted or sprayed on to the foliage, with the intention of acting as an internal poison to the insects when feeding on the leaves. These compounds are nearly always arsenical in nature, and as such are barred from use on the tea bush, for obvious reasons. Lead chromate, at one time advocated for Tortrix, is sufficiently cheap to warrant its employment on this score, but it has been proved to be entirely ineffective in destroying the larvae.

Internal poisons being practically prohibited, the question is therefore reduced to one of contact poisons. Insecticides that kill by contact are usually so corrosive in action as to scorch or otherwise damage the foliage to which they are applied. There are, however, certain proprietary compounds, innocuous to the bushes, that have been claimed to be capable of destroying the Tortrix larvae by direct application. But here the question of cost comes in. On account of their high cost proprietary in-

secticides are usually employed, only for the treatment of small areas, and for such purposes they are frequently of great value. Although, therefore, the question of spraying and dusting insecticides has not received much attention, and should certainly be tested out, it is likely that such treatment will be of benefit only as an auxiliary measure.

This discussion of the possible employment of chemicals in Tortrix control would not be complete without the mention of a substance that has come to the fore of recent years, namely, Calcium cyanide, by which the poison is supplied in gaseous form. Preliminary tests on Tortrix have already been carried out in this country by Dr. W. E. Brittain, of Nova Scotia, assisted by the Department of Agriculture. These trials indicated that some difficulty might be experienced in dealing with the larvae, on account of their habit of harbouring inside the webbed-up leaves, which present a considerable barrier to the penetration of the gas. But it is only fair to state that these elementary trials were conducted under conditions that were far from ideal, and with improved apparatus and further experimentation, better results might accrue.

Parasites and other Natural Enemies.—Tortrix, like every other insect pest of importance, is subject to the attacks of numerous parasites. In 1918, seven species were recorded,—two egg-parasites, four larval and one pupal parasite. This number is undoubtedly much below the total number that actually attack Tortrix, for in a short preliminary tour in Maskeliya several additional larval parasites were taken by the writer.

As pointed out by N. K. Jardine in 1918, parasites that attack the egg are the most valuable, for they destroy the pest before it has committed any damage whatsoever. But, unfortunately, these are apparently rare. The actual number of eggs in a mass which are attacked by one egg-parasite is probably quite large, for when a single individual (Trichogramma sp.) was captured in Maskeliya, and allowed to oviposit in a Tortrix egg-mass. 35 parasites hatched out, although the conditions were unusually adverse. In addition to these, 19 more were discovered unemerged in the egg-mass, so that at least 25 per cent. of the eggs must have been parasitised by this one insect.

Larval parasites, especially Braconidae and Ichneumonidae, are far more numerous, and in places, it would appear from observations by the writer, they are probably instrumental in suppressing attacks to a certain degree, provided the latter be not severe. This, however, needs confirmation. Perhaps the commonest species amongst the larval parasites is the Ichneumon, *Phytodiaetus capuae*, whose larva lives as an ecto-parasite attached behind the head of the Tortrix caterpillar.

Pupal parasites may be almost disregarded, since they rarely occur; unless abundant, such parasites are of little value, since their attack commences after the caterpillar has finished its full life of damage on the tea.

From the preceding remarks there naturally arises the question, "Can the factor of parasitism be utilised for the control of Tortrix?" This question must, for the present, remain unanswered, for no attempt has so far been made to introduce foreign beneficial insects for this purpose, or to propagate the existing native species. But on so many occasions have insects been successfully utilised in other countries for the purpose of combating various pests, that I consider it advisable that the possibility of this method should be investigated in relation to Tortrix in this island.

The advantages of this mode of control are obvious. Although a good deal of labour, and possibly expense, is necessary in the first place, yet if effective parasites should be established in the country, a great saving in time and money would result, and the minimum of co-operation would be required on the part of the planter. At the same time, it must be fully realised that, just as with the other methods employed, there is little hope of entirely exterminating the Tortrix moth by the use of parasites, for it is an essential feature of parasitism that the parasite can usually exist only on its own particular host (in this case Tortrix), and as the host is gradually killed out, the parasite correspondingly decreases in numbers. Thus no severe pest is ever entirely eradicated by parasitism alone. The actual control of Tortrix by parasites would consist of the appearance of the latter shortly after the commencement of an attack, and the rapid overhauling of the Tortrix pest, with the result of keeping it down to a low level, where its ill-effects would be almost negligible. This is what we might expect if parasites were effectively established in this country.

The chances of propagating the most useful of our native parasites, the egg-attacking species, are, I fear, remote, on account of their scarcity. Attempts would, therefore, have to be made to import foreign egg-parasites. One or two of the indigenous parasites of the Tortrix larva may possibly be worth cultivating. It is a fact, however, that the best results in other countries have been obtained by the use of foreign insects, owing to the many difficulties experienced in attempts to increase the naturally-existing numbers of an indigenous species. As an example of these difficulties, we may mention hyper-parasites, that is, insects that parasitise the parasites. In a week's tour in Maskeliya, while ten species of parasites were taken, seven different hyper-parasites were discovered.

It may be mentioned, incidentally, that there is little hope of obtaining effective parasites from India, since Mr. Andrews, of the Indian Tea Association, stated, not long ago, that although Tea Tortrix was widely distributed throughout North-East India, no parasites had so far been discovered. But that does not, of course, preclude the possibility of discovering a suitable parasite attacking an allied species of moth.

As far as is known, no predatory (as distinct from parasitic) insect has yet been found to attack Tortrix to an extent worth recording.

It is a well-known fact that Tortrix numbers amongst its enemies, not only insects, but bats, lizards. birds and other vertebrate creatures. It has, therefore, been suggested that birds should be utilised for the destruction of the Tortrix caterpillars. This question will be dealt with further on, under the heading of " Bird Encouragement."

The utilisation of the " wilt " disease that is so prevalent amongst the larvae, especially in severe attacks, was discussed in 1918, but I am not aware that any definite work was done in this direction. Although the artificial dissemination of this disease is much to be desired, the chances of success are extremely slight, judging by the negative results obtained from similar attempts in other countries.

Cultural Treatment.—The application of manures for the control of Tortrix has been but little followed, though observations have been made on this point by some planters. It would be difficult to prove that definite benefit had been derived from manurial treatment, and no attempts to do so have yielded definite evidence. It has, indeed, been claimed that potash has in some cases produced beneficial results, but the evidence is hardly conclusive; Andrews' experiments on Helopeltis in India appear to argue in favour of potash. Detailed experiments with various manures might throw light on the subject.

Miscellaneous Measures.—In addition to the " active " methods already enumerated, various others have, from time to time, been attempted, but with little success.

The use of smoke-screens, presumably with the object of stopping the flight of the moth, possesses so many obvious disadvantages, not the least of which is the effect of wind, that it hardly merits consideration.

Slaked lime has been dusted over the bushes as a destructive, or at least a deterrent, agent to the larvae, but its results, as witnessed recently by the writer, would appear to be absolutely nil.

Beating the bushes, so that the larvae fall to the ground, has more foundation for success. From brief observations that

have been made, it appears that the larvae, when shaken to the ground, lose, for the time being, their sense of direction, and wander about aimlessly, seeking to escape the rays of the sun. They are thus more exposed to the attacks of birds and other predators, but ultimately, one imagines, if they escape these, they arrive beneath the shelter of a tea bush and possibly re-ascend into the foliage. No data, however, are forthcoming with regard to this point. In any case, beating the bushes can only be described as an auxiliary measure.

The use of trap-crops (this is, strictly, a "passive" method) gives little hope, since, of the many food-plants of Tortrix it evidently greatly prefers tea.

The following form what I have termed the "passive" measures of control:—

Laisser-Faire.—The principle of leaving Nature to herself, in the hope that natural agencies may in time bring about the suppression of the pest.

The chief foundation for the proposal is the occurrence of "wilt" * disease amongst the caterpillars. It is clear from a little observation, that when attacks are severe, and the caterpillars become abundant and closely crowded, this disease invariably occurs, and is probably one of the chief factors in ultimately suppressing the attack. "Wilt" is greatly assisted by rainfall; damp conditions certainly hasten its effect.

On this account, therefore, it has been stated that it is preferable to leave an attack to itself rather than to apply partial measures of control that will result in merely thinning out the caterpillars, with a consequent strengthening of the stock and resultant increase. This is probably true, and serves to emphasise the fact that control measures must be carried out whole-heartedly. But since there is no evidence to show that on estates where "laisser-faire" has been followed (and this method has been in practice for the last 30 years), the least advantage has been gained, this principle cannot be said to promise success.

One of the arguments put forward in support of the theory is that after an attack a luxuriant output of flush results, which compensates for what is lost through damage to the leaves. This suggestion may be entirely set aside by the reflection that in mild attacks the increase in yield is negligible, and in severe attacks, whereas the increase lasts for one round of plucking only, the damage done may extend to three or four rounds.

High Shade and Bird Encouragement.—A great deal of attention, both in discussion and practical endeavour, has been devoted to the use of high shade, in the form of Albizzias, Grevilleas and other estate trees. Considerable difference of

* This term includes, here, the condition described by Jardine as "scour."

opinion exists as to the actual effect of these trees in minimising a Tortrix attack.

Numerous estates have distinct evidence to show that on areas where high shade is closely grown, attacks have almost invariably been less severe than on areas with little or no high shade. So many confirmations of this exist that it would appear that some deterrent effect must be exercised by the presence of the trees. On the other hand, it is certain that this effect is not invariable, for it has frequently happened that the most densely-shaded areas have suffered equally with, if not more than, the unshaded portions of the estate. At the same time, I believe, from personal experience and from the opinions of the planters themselves, that high shade has, usually, a definitely beneficial action in preserving the tea, at least partially, from the attacks of Tea Tortrix. The explanation of this action is another matter, and one that is at present wrapped in uncertainty.

One of the most significant suggestions that have been put forward is that high shade favours the activity of bird life in suppressing the pest, but, although this is probably true, little proof exists of the effectiveness of birds as a controlling factor, and even shaded estates, where birds are highly encouraged, are sometimes severely attacked. The exact relations between bird life and high shade, as affecting Tortrix, have not been discovered, and yet remain to be worked out. At present, all that can be said is that certain species are decidedly more partial than others to a diet of Tortrix larvae; amongst the most useful in this respect are the species of White-eye, the Ceylon Robin, Babblers and Minivets.

One of the most important questions to answer in dealing with high shade is the following:—" Does the shade protect the tea by affording an effective breeding-ground for the insect, or do the trees attract the moths and add to the infestation by increasing the numbers of the pest already on the estate, and forming an additional source of infection ? " There again, I am as yet unable to give a definite reply. However, in answer to the first part of the question, it may be stated that on occasion the shade probably does act as a protection, for from a brief study of various trees, I am able to say unhesitatingly that Tortrix is capable of breeding quite freely in certain species, particularly Albizzias and Acacias. Again, on estates where the tea is lightly infected, an infestation at least equal to that of the tea has been observed in adjacent shade trees. In this connection, it is important to note that Tortrix has been found by the writer breeding readily in Albizzias 40 feet from the ground. By a calculation made from examination of a number of infested shoots, it is evident that the number of Tortrix in various stages (excluding egg-masses) may amount, in the case of a large 50 ft. Albizzia,

to 5,000-10,000. On thickly shaded estates, therefore, considerable quantities of Tortrix, that would otherwise attack the tea, must be confined to the high shade.

On the other hand, in reply to the second part of my question, there is undeniable evidence to show that infestation from the trees can and does occur, for larvae have very frequently been observed, suspended by their silken threads, dropping on to the tea below. But the statement, as I have observed it in print, that the larvae drop down because they are *unable* to develop further in the foliage of the tree, is entirely erroneous in the case of Albizzias and Acacias, at least: this is shown by the fact that in the Albizzias above-mentioned larvae in all stages were discovered webbed-up in the leaves. With Dadaps there is certainly some likelihood of the statement being true.

A tentative explanation of this apparent disparity in the behaviour of Tortrix in high shade is that the insects may breed readily in the trees, provided that climatic or other conditions be suitable, but that when adverse conditions set in, the larvae drop down into the more readily adaptable tea.

An interesting point raised by the examination of the Albizzias is evidence to show that infection on estates may occur through larvae carried by the wind. The nature of this evidence, which requires confirmation, is as yet too early to discuss.

Turning again to the subject of birds,—I have already referred to the proposal that these should be utilised for Tortrix control. With regard to this, it has been suggested that a certain species should be selected and encouraged to feed on Tortrix from infancy; by this means a race might be bred up which would turn to Tortrix as their natural food. But it is necessary to point out here that the elementary laws of heredity indicate that such a happy outcome might not be attained through thousands of generations, if it ever occurred! One of the great difficulties to be faced in the encouragement of birds is, of course, the fact that estate coolies wantonly destroy all nests within reach. Another trouble is the increasing scarcity of natural breeding grounds, through the yearly opening-up of fresh land for tea-growing.

In summing up, I would say that although little explanation of the action of high shade is at present forthcoming, I believe that there is sufficient evidence to show that the encouragement of high shade is a measure to be recommended.

Flight Breaks.—By this term is indicated the establishment of belts of trees across the line of flight of the Tortrix moths, so as to impede their flight and offer protection to the tea. Flight breaks were advocated years ago by E. E. Green as a measure to apply on continuous stretches of tea-land open to Tortrix infection, and the scheme was elaborated more recently by N. K. Jardine.

From the beginning it may be said with confidence that flight breaks could never be applied as a general measure; for example, on steep slopes directly facing the line of flight, such belts would have to be almost as numerous as the rows of teas for real benefit to result. Under certain circumstances, however, I believe that flight breaks have a definite value. Few estates have taken up this method of control, and in most cases it is as yet too early to give a definite opinion on the result. In some cases the method has been abandoned for various reasons, but the only estate that has, to my knowledge given the method an extended trial, has been rewarded by marked success, and it seems reasonable to suppose that other estates may benefit in the same way. In this case the tea was allowed to run up for four years in belts two or three rows thick, accompanied by belts of *Acacia decurrens*, which are now gradually replacing the tea. Experiments are being conducted on the same estate with a view to testing species of *Hibiscus* as a possible medium for this purpose. There also appears to be some evidence of the utility in this connection of Boga Medeloa (*Tephrosia candida*).

With regard to the height that flight breaks should be allowed to attain, I do not think that any definite limit can be fixed: this must be ascertained by trial and observation for different cases.

At one time, spraying flight breaks for the destruction of the accumulated larvae was advocated, but this suggestion is open to some comment. The troubles accompanying the spraying of tea would be incurred, with the addition that more powerful, and therefore more unwieldy, apparatus would be required to spray the belts of trees. Again as mentioned before, no substance has yet been established as suitable for dusting or spraying against Tortrix on a large scale: although there would be no fear of tainting, as with tea, in using arsenicals, the usual difficulties with native labour would be encountered.

One of the features of this method that has debarred many planters from adopting it is the fact that 4 or 5 years are necessary for the full effect of the flight breaks to be attained. This is true enough, yet at the same time, if flight breaks prove a success, they will afford a measure of control for future use, and will require little to maintain them.

Finally I would emphasise the fact that flight breaks cannot be applied as a haphazard measure; before their use is attempted, a careful study is necessary for such considerations as the lie of the land in relation to the Tortrix flights and to the prevailing wind.

Conclusion.—A study of the methods enumerated above makes it evident that the majority are probably of little or no value as measures of control. The only ones that hold out any

promise of success as general measures are the employment of parasites, egg-mass collecting and the use of high shade, combined perhaps with the encouragement of birds. Flight breaks, although not of general application, might be of value in some cases: stripping and the use of insecticides offer partial control. Manurial treatment is at present an unknown quantity.

Since none of these plans has been proved capable of solving the problem, what obviously remains to be done is the testing-out of the most promising methods in the endeavour to find one that will fulfil the necessary conditions of control. In the meanwhile, it is essential that some definite and organised line of action be adopted during the period necessary for research on this subject.

None of the measures that are now in use is ideal: this, it is hoped, is freely admitted on all sides. But of all these, the only active measures that can at the present juncture be advocated with any degree of confidence, are egg-mass collecting and the allied methods. Other methods may offer greater promise ultimately, but they require more evidence for recommendation, and further study in manner of application.

It has been argued by more than one planter that they have given the system of egg-collecting a thorough trial, without success But it is possible that such estates as theirs are particularly liable to infection from other quarters, whereas those where collection has proved successful are not exposed to infection to the same extent. Thus in this method one of the main considerations is, in all probability, infection from adjoining estates. And this introduces a factor in egg collecting upon which the greatest emphasis must be laid, namely, the necessity for co-operation. It is extremely likely that the lack of universal co-operation in the past has frequently accounted for the repeated failure of egg-mass collecting on various estates, especially in the Maskeliya district. The reason for this is obvious; no amount of destruction carried out on a given estate will stem the tide of Tortrix if a constant supply is passing over from neighbouring estates where the same endeavour to eradicate is not in progress. Whether or not egg-mass collecting will suffice to deal with Tortrix by reducing its attacks to a negligible quantity, remains to be seen; one thing, however, is certain, that the only fair trial that can be applied to this method is the co-operation of the whole of the infested areas in an united campaign of egg mass collecting.

I recommend, therefore, that the collection of egg-masses and the squashing of caterpillars should be adopted as part of the routine of the estate, by a special gang if necessary.

Stripping off the young growth on an affected area might be adopted as an auxiliary measure where small areas are attacked, but it should not replace the collection of egg-masses.

At the present time, no other recommendation is possible.

Note.—It should be explained that this article was prepared before the publication of Dr. Hutson's notes in the Year Book of the Department of Agriculture for 1927.

References.

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Correspondence.

ROOT DISEASES OF ECONOMIC CROPS.

A Reply to Dr. W. Small.

BY

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THE view expressed by Dr. Small in his paper "A review of recent work on root diseases of economic crops," read at the last Agricultural Conference at Peradeniya, is both novel and alarming. It is novel in that certain fungi, which in Ceylon and elsewhere have been regarded by experienced mycologists as the primary causes of definite serious diseases, are now to be regarded as harmless or relatively so, and that diseases with very different and distinct symptoms are now all to be considered as the results of the parasitic activities of one fungus--viz. *Rhizoctonia bataticola*. It is alarming because this omnivorous fungus is everywhere present, it is only a matter of time before its presence becomes more notably evident, and because no satisfactory remedy is likely to be discovered in the immediate future.

Concerning this sinister fungus, *Rhizoctonia bataticola*, Dr. Small states :--

(1) "My interpretation of the meaning of the presence of the Rhizoctonia involves a complete change from the accepted view of the causation of root disease in the tropics." "I conceive of *Rhizoctonia bataticola* as the basic cause of root disease in Ceylon. It is, as it were, the foundation on which other fungi build."

(2) "The complete list of victims (host plants) is now about thirty in number. It includes tea, rubber, cacao, coffee, beans, dadap, *Albizzia*, *Acacia*, *Grevillea*, *Tephrosia*, *Clitoria*, soursop, custard apple, chillies, tomato, lime, orange, plantains and several ornamental and useful trees and plants." "It is conceivable that the 'Diplodia' dieback (of rubber) is nothing more than a symptom of the presence of root disease underground . . . . . Similarly the common dieback and gumming of lime trees may be attributed to Rhizoctonia root disease, and so also may the gumming of Acacia, Grevillea and other stems. Dieback of the aerial parts of a tree is to be regarded on the whole, as a symptom of other trouble, most probably of root disease, and I am not prepared to believe in an independent fungus cause of dieback of local woody plants unless I am convinced that root disease is not present, especially *Rhizoctonia bataticola* root disease."

(3) "There is no doubt that Rhizoctonia root disease will always occur when the fungus is present in the soil."

(4) "It has been found that *Rhizoctonia bataticola* occurs in the soil of all the planting districts of Ceylon. It does not seem to be confined to certain types of soils or be more common in certain soils than in others, and elevation has no influence on its distribution."

(5) "It possesses a pycnidial stage which grows upon the aerial parts of plants, for example, the stems of jute in India. This pycnidial stage produces spores and when the spores fall to the ground and germinate they give rise to the Rhizoctonia stage of the fungus. It is therefore conceivable that the distribution of the pycnidial spores by natural agencies like wind and rain, and their germination in the soil when conditions are favourable account for the wide distribution of the Rhizoctonia. If this theory proves to be sound it will follow and will be proved, I hope, that the pycnidial stage of the Rhizoctonia is fairly common in Ceylon."

(6) "It is not a practicable measure to attempt to eradicate the fungus from the soil."

(7) "The only measure that can be recommended to the practical planter is that he should promote the health of his plants by all means in his power. Unfortunately, success in avoiding Rhizoctonia root disease cannot be guaranteed to follow that measure, for it is clear that the healthy well-grown trees and bushes fall victims to the fungus and it is to be feared that they will continue to do so."

This short summary presents a somewhat gloomy picture. When it is remembered that the action of this fungus on woody plants is slow, that deaths do not take place, as a rule, until the trees are old and large enough to fulfil their purposes, and that all our Ceylon soils contain this pernicious fungus, *Rhizoctonia bataticola*, the fact that fresh infections are continually occurring owing to the distribution of spores from at present unknown sources, is somewhat disturbing. It must be evident, if Dr. Small's view is correct, that the prospects of our main agricultural industries in Ceylon are anything but bright.

Fomes, Poria and other fungi, which in the past we have looked upon as the causes of our more serious diseases, are not peculiar to Ceylon. They occur in India, Java, Malaya and other tropical countries where the scientists who advise our planting rivals, also regard them as primary causes of disease. If it proved in Ceylon that those root diseases which we have previously attributed to the activities of Fomes, Poria, etc., are in fact due to *Rhizoctonia bataticola*, it must follow that Fomes, Poria, etc., are not the real causes in Java and Malaya also. That Dr Small shares this view is evident from his statement:— "There are many countries in which I personally have no doubt *Rhizoctonia bataticola* is present and undetected on such crops as tea, rubber, cacao, and citrus, and I think it is only a question of time and investigation until the fungus is run to earth, so to speak, and until its suspected great economic importance is realised in full." For those who like companions in distress it may be some consolation to realise that their rivals outside Ceylon will be in the same boat.

It is of more importance for a practical planter to know how to treat specific diseases than to know full details concerning their causes. But efficient treatment is dependent, to a great extent, upon the nature of the cause. When the cause of a disease is a living organism, a full knowledge of its habits and life history has to be acquired, in order that the best method of limiting and stopping its activities may be devised. The present methods of treatment for our more serious root diseases have been based upon studies of the life history, method of dispersal or spread of those fungi known as Fomes, Poria and Rosellinia. It must follow that

unless *Rhizoctonia bataticola* is similar in habit to these fungi, the treatment practised will not be suitable if the real cause of the trouble is *Rhizoctonia bataticola*.

The present treatment of those diseases known as Fomes, Poria and Rosellinia consists essentially of (1) starving the fungus out of the soil by the removal of all roots upon which it may feed and from which it may grow out to reach other bushes or trees suitable for attack, and (2) the construction of a barrier in the form of a trench in front of the fungus to prevent it reaching other bushes or trees *via* the soil. If I understand Dr. Small aright, *Rhizoctonia bataticola* does not spread by contact. I quote from the Transactions of the British Mycological Society, Vol. X. p. 290. " But careful search has not revealed a single instance of infection by contact. It was supposed that a young tea plant and an arnatto affected by the Sclerotium *(now Rhizoctonia bataticola)* had acquired the root disease through their proximity to diseased *Grevillea robusta*, but an examination of numerous examples of the new hosts of the fungus has not produced any evidence of its spread by contact. It seemed, therefore, that independent infection was the rule rather than the exception, and that the incidence of infection of woody plants was governed more by the degree of susceptibility of the host plant and the presence of the fungus than by such external conditions as control the health of the plants." That view appears still to be maintained by Dr. Small, as the only remedial measure he can recommend to the practical planter is that he should promote the health of his plants by all the means in his power. It must follow that, if the cause of all our root diseases is the fungus *Rhizoctonia bataticola* the present methods of treatment are waste of energy and money. We are merely throwing good money after bad.

Such a view must be strongly resisted. I am informed, accurately I believe, that the incidence of root disease in both tea and rubber at the present time is markedly less than in the past, say between 1906 and 1912. The improvement in the position regarding root diseases synchronised with the adoption by estates of the present methods of control, together with the systematic removal of old stumps. The success achieved by these methods has certainly justified their adoption. I also find it difficult to conceive that the Ceylon Planter would have continued these methods of treatment, as they are expensive, if he had not been satisfied with the improvement resulting therefrom. If the success of the treatment is admitted, the correctness of the principles on which it was founded is tacitly implied.

As there appears to be some evidence indicating the accuracy of the old ideas, viz. that Fomes, Poria etc., are the active parasites, it behoves us to look closely into the reasons for discarding those ideas and for accepting the new hypothesis that all root disease is due to the activities of one fungus *Rh. bataticola*, before we abandon methods of treatment which have been found satisfactory and substitute another, the success of which its author cannot guarantee.

Dr. Small rather summarily dismisses the old ideas with the following statement. " Fomes and Poria, not to mention others, are presumed to be truly parasitic because of their supposed sole association with frequent cases of root disease, but, as already indicated, recent investigation has shown that they are never in sole association with cases of root disease, and that in fact, they have been accompanied by *Rhizoctonia bataticola* in every case examined of late." I cannot call to mind any scientist who has ever based any claim for the parasitism of Fomes or Poria on the supposed or proved *sole* association of the fungus with its host. It is the common experience of mycologists and pathologists in general that as soon as the tissue has been killed by one organism, other organisms appear and sometimes so

crowd out the original invader that the latter is difficult, almost impossible, to find. I would go still further than Dr. Small and state that every diseased root bearing Fomes or Poria is accompanied by *numerous* other fungi besides *Rhizoctonia bataticola*. Most mycologists, I think, will agree with this statement. If, then, the presence of another fungus on the diseased roots is sufficient to disprove the parasitism of Fomes, the same argument is sufficient to upset any similar claim made for *Rhizoctonia bataticola*. But, as no claim has ever been made or is likely to be made by an experienced mycologist that Fomes, Poria or other parasitic fungus occurs in *sole* association with frequent cases of root disease, Dr. Small's statement quoted above does not afford any reason for displacing those fungi from their established position.

Dr. Small offers a number of reasons for considering *Rhizoctonia bataticola* to be a parasitic fungus which causes all the root diseases of our economic crops. We will now proceed to examine those reasons in detail.

1. "First, there is the evidence of cases of root disease in which there are no complications, that is, cases in which the Rhizoctonia occurs alone and must therefore take all the blame for the disease caused." On first reading this statement one wonders whether Dr. Small really intended the words "occurs alone" to be interpreted literally. The frequent repetition of such statements as "occurs alone," "sole association" and "it was determined by a careful examination that no other fungus was present" leads one to infer that these terms convey exactly what Dr. Small meant. I have already stated that the occurrence of a single fungus on dead tissues is almost, if not quite, unique. I would ask Dr. Small whether he really means that no fungus other than *Rhizoctonia bataticola* can be cultured out of the dead roots, including the cortex and the wood, of the specimens he refers to. If other fungi can be cultured out of the material then *Rhizoctonia bataticola* evidently does not occur alone, and without further definite evidence *Rhizoctonia bataticola* has no greater claim to parasitism than have the other fungi present. If, however, we allow for the sake of argument that *Rhizoctonia bataticola* does occur alone, I still maintain that it constitutes no proof of parasitism.

It has frequently been stated, probably with very good reasons, that some of the roots of a tea bush die back at every pruning as the result of pruning. It is admitted that *Rhizoctonia bataticola* is common in the soil and appears to prefer woody matter as a source of food supply. Then, is it surprising that this fungus should be found in these dead roots? It is more surprising to be informed that this fungus killed the roots. Is it not probable that some of the finer roots of any tree die off periodically as they are replaced by new roots, particularly when the trees are growing in an unsuitable environment or in infertile soil, such as is usually the case when rubber trees are affected by dieback such as Dr. Small describes in one of his examples? The presence of *Rhizoctonia bataticola* in such roots is satisfactorily explained on the simple basis of saprophytism, i e, the fungus will live only on dead tissues. I would suggest, then, that the cases in which Dr. Small states there are no complications, are too frequently complicated by environmental conditions.

2. When "more than one fungus is present it is to be noted particularly that *Rhizoctonia bataticola* has been found to be present in every case." Here again the presence of Rhizoctonia may be explained as a saprophyte. The dead roots resulting from the attack by one of the established parasites form an excellent medium in which this common soil fungus can grow.

3. "The Rhizoctonia precedes in time of attack the other fungus Fomes or Poria or Ustulina which may occur with it." Dr. Small lays great emphasis on this question of priority in time of attack but I submit

that it is a most difficult matter to prove. We need consider only one case which Dr. Small describes in detail. "In the case of a rubber root disease, a group of dying trees was found on the roots on which only *Rhizoctonia bataticola* was present... ..... It was determined by a careful examination that no other fungus was present." This latter is rather a bold statement to make after an examination, apparently *in situ* in the field, of such a large root system as that of a rubber tree. If Fomes had been present in an advanced stage it would have been easy to recognise, but might it not have been overlooked in its incipient stage in all that mass of roots? Without suggesting that Fomes or other parasitic fungus was the cause of the trouble, is it not possible that Rhizoctonia was the first saprophyte to establish itself in the dead roots present as the trees were moribund? "After the lapse of five months it was found that the Rhizoctonia had been followed by *Fomes lignosus*, *Fomes lamaoensis*, Ustulina and diplodia, and all these four fungi were found together on more than one tree along with the original attacker, the Rhizoctonia." Dr. Small omits to state whether the trees were dead. It would be very surprising if any of them survived the necessarily thorough preliminary examination from which it was determined that "no other fungus was present." After such treatment the presence of any soil fungus on the roots merits no comment. My point is that if any great importance can be attached to priority in time of occurrence, priority itself is most difficult, if not impossible, to prove concerning fungi on roots in the field Certainly Dr. Small's evidence is not convincing.

4. "It adopts a most natural means of entry into its host, namely *via* the smallest feeding roots, and after establishing itself, so to speak, it grows inwards and upwards always getting nearer the larger roots killing or poisoning as it goes." In my opinion, the statements made in this sentence, if they could be substantiated, would form the best reasons for considering *Rhizoctonia bataticola* as a parasite. Possibly Dr. Small does not agree as he has offered less evidence on this point than on any other. The claims made here require very careful consideration. It must first be recognised that penetration through the smallest feeding roots as a most natural means for a fungus to enter its host is mere opinion. Does it also imply that the most natural means of entry for an aerial fungus is *via* the finer twigs? If so, all our major stem diseases like cacao and rubber canker, pink disease, and so on are exceptional. So are the soil fungi, like *Pythium Debaryanum* and *Rhizoctonia solani* which attack seedlings at the collar and cause serious losses in seed beds. I know of no very sound reasons for believing that the finer roots are easier of penetration by fungi than are other parts. The easiest way is the most natural way, and if any fungus finds it easier to penetrate older roots or the collar, then that fungus, in the majority of cases, will enter the older roots or collar in preference to the finer roots.

Admitting as an actual fact that Rhizoctonia enters the finer roots first, as Dr. Small's evidence is conclusive on that point, we have to consider evidence in support of the statement that, after establishing itself, the fungus grows inwards and upwards getting nearer the larger roots, killing as it goes. This is a far more important point than priority in time of attack and is usually more easy to prove. Here we can visualise an advance, a parasitic fungus ahead, killing as it goes and all the numerous saprophytes following it and feeding on the dead tissues. But note that the parasite is ahead, doing the killing. The leading fungus in this advance is always the one to which first attention is paid by mycologists, as a rule. When investigating an unknown disease, the cause of which is suspected to be a fungus, the mycologist usually attempts to isolate the fungus from the advancing edge of the diseased tissues. He takes tissue under sterile conditions from the apparently healthy margin, hoping to obtain cells in

which the parasite is in the act of killing, and which are not sufficiently moribund to allow the entry of pure saprophytes. If successful, he obtains a pure culture of the advancing fungus free from the saprophytes which normally follow. There is no means of determining whether an unknown fungus is a saprophyte or parasite by merely looking at it. The fact that a fungus is in the very van of the attack makes it worthy of further study and it will be found by experiment in nine cases out of ten that this fungus has a parasite habit.

The presence of *Rhizoctonia bataticola* at the head of the advancing disease, killing as it goes, and followed by Fomes and a host of saprophytes would afford some evidence of the parasitic nature of the Rhizoctonia. But Dr. Small does not claim that Rhizoctonia leads the attack by position, in fact he admits that it does not. In short *Rhizoctonia bataticola* constitutes a "Storm battalion" which is always in the second or third line during the main attack.

It will be noticed, despite my incomplete quotation, that Dr Small says "killing *or poisoning* as it goes." The importance of the part "*or poisoning*" will now be evident. It affords a reason why Rhizoctonia is not to be found in the forefront of attack. The reason is that *Rhizoctonia bataticola* emits an unknown poison or toxin such that it kills the host tissues without this fungus having to penetrate them. He says "The Rhizoctonia has been noted to kill or poison well in advance of its actual penetration, its host or the part of its host that it has attacked, and it is likely that it is enabled to do so by the production of a toxin which is poisonous to the plant attacked."

"In this way it may be conceived as providing, by its lethal effects on the larger roots and eventually on the collar of the attacked tree an easy means of entry for secondary fungi in this country, which prove to be Fomes, Ustulina, Poria, etc. I have not been able to find in any of Dr. Small's writing on this subject one tittle of direct evidence in support of the presence of this poison or toxin. It is evident, however, that this hypothetical toxin is necessary to explain the secondary position of the Rhizoctonia when the primary position is claimed for it. It must be admitted that such toxins are not unknown in plant pathology but the number of such toxins which have been definitely demonstrated is very small.

To me it seems unnecessary to call in the aid of this unknown toxin to explain the observed facts. I submit that in occupying a secondary position in the attack *Rhizoctonia bataticola* is occupying its true position, the place where one always finds the saprophytes, including this particular fungus.

5. Experimental proof:—Positive results with his inoculation experiments have been few. Dr. Small claims that "the parasitism of *Rhizoctonia bataticola* has been proved by experiment with more reference to herbaceous plants like beans than to woody plants like tea, rubber and cacao." It is with the latter that we are more particularly interested. Since *Rhizoctonia bataticola* is said to cause various types of disease, most of which are fatal, under all sorts of conditions and in all types of soil, and since it is stated that healthy plants are attacked, there should be little difficulty in reproducing at least some of the types of disease, under laboratory conditions with pure cultures of the fungus. Dr. Small has experiments in progress but results are not yet available. These results together with full details of the conditions of the experiments will be awaited with interest. No criticism of these experiments can be made until the full details are published.

In the foregoing, I have attempted to show that the reasons advanced for the claim that *Rhizoctonia bataticola* is the only parasite of present importance in the causation of root disease and its secondary results, are not sufficient to establish the fact that this fungus is a parasite at all. I have

shown incidentally that the observed facts may be accounted for more simply on the basis that *Rhizoctonia bataticola* is nothing more than a common soil saprophyte. Before leaving the subject I would offer a few remarks concerning the occurrence of our root diseases in the field. I shall confine my remarks to Tea, as it is with that crop I am at present intimately associated.

We can divide our tea root diseases into three types. The first will be known to tea planters by the name of Poria or Rosellinia.

This type spreads through the fields very readily and many planters are only too well aware how difficult it is to control. The second may be known as Brown root. This disease does not spread to any extent; it is usually associated with old stumps and is normally easy to eradicate. The third type is that of the Diplodia root disease. This disease usually crops up after pruning and affects a whole area at once. When once the critical period is passed, it is unlikely that anything more will be noticed of this disease until next pruning. These three types can be readily distinguished without any reference to the fungi associated with them. If, as Dr. Small states, these three types are due to a single cause, viz., the attack of *Rhizoctonia bataticola*, it appears material to ask why the disease should sometimes occur as one type, sometimes as another, without any apparent rhyme or reason. The older explanation, viz,. that these types are due to distinct causes, appears to be much more reasonable.

I have already quoted a passage indicating that *Rhyzoctonia bataticola* does not spread by contact, but that independent infection is the rule. How then are we to interpret the spread of those diseases which in the past we have ascribed to Poria or Rosellinia, through an area of tea when we can see bush after bush succumb in regular succession? Is there some more subtle explanation of this apparently simple phenomenon, observed and recorded by so many planters and scientists? As the Poria disease spreads from bush to bush while Brown root disease does not, to any marked extent, and both are due to the attacks of fungi, it must be obvious that the fungi which cause these diseases have markedly different habits. The introduction of a third fungus, which admittedly does not spread by contact does not assist the explanation. Before *Rhizoctonia bataticola* can be accepted as the only parasite of present importance in the causation of root disease in Ceylon some very satisfactory explanation must be offered to account for the everyday observations in the field.

I have criticised at some length the views expressed by Dr. Small as to the primary cause of our Ceylon diseases for two reasons. Firstly, the view that *Rhizoctonia bataticola* is the primary cause of all root diseases is but a hypothesis. Before a hypothesis can be raised to the rank of a theory, all adverse criticism must be satisfactorily met and it must be shown that the hypothesis is the best and truest explanation of the observed facts. I have tried to advance legitimate criticism, and I have suggested a simpler and more feasible explanation of the observed facts than that given by Dr. Small's hypothesis. Secondly, emanating as they do from the Government mycologist, his views should carry some weight with the planting community; and if his views are accepted and acted upon, the present method of treatment of root diseases will have to be abandoned as useless and wasteful. I have tried to show that the conclusions he has drawn from observed facts are not convincing, and that he has failed, as yet, to afford sufficient reason for a reconsideration of the accepted and established causes of our known root diseases. Until some tangible proof to the opposite is afforded, the vigorous measures to prevent the spread of our soil parasites must be continued. The cessation of those methods in favour of the sole recommendation to promote the health of the plants by all means, judging from past experiences in Ceylon, would be utter folly.

If Dr Small's views are correct we shall require to know every little detail concerning the habits and life history of this fungus *Rhizoctonia bataticola* in order that its ravages may, to some extent, be controlled. For that reason it has been advocated that Dr. Small be afforded opportunities of continuing his researches on this subject. His researches will be watched with interest and his publications closely studied for some tangible proof of the correctness of his views.

Rhizoctonia bataticola & Root Disease

A Reply to Dr. C. H. Gadd's Criticism of my Views.

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THERE is no justification for the attempt by Dr. Gadd to show that the recently-disclosed presence of *Rhizoctonia bataticola* in cases of root disease of economic and other plants in Ceylon and the views held by me regarding the harmfulness of the fungus give reason for alarm in agricultural circles. He has said, for example, that it is "only a matter of time before its presence becomes more notably evident." He means, it is presumed, that the proved presence of *Rhizoctonia bataticola* and my views upon its responsibility for root disease imply that the immediate or near future will see an increase in the amount of root disease in the field and that *Rhizoctonia bataticola* will be responsible for that increase. There are no grounds for such a deduction. The finding of a new fungus cause of root disease does not imply that the fungus in question has begun only at the moment of its discovery to cause disease or that it is likely to increase its efforts in the future. On the contrary, it is held, not without reason, that *Rhizoctonia bataticola* has been present in Ceylon soils and has been in operation as a cause of root disease in the past. It follows that, as far as the *Rhizoctonia* is concerned, field conditions affecting the amount or incidence of root disease have not changed; in other words, *Rhizoctonia bataticola* has been and still is doing its worst. As far as Ceylon is concerned, there is nothing new about *Rhizoctonia bataticola* except its recent discovery and my interpretation of the meaning of its presence. I attempted to make this point clear when I wrote in the *Tropical Agriculturist* of last October (67, p.237) with reference to *Rhizoctonia bataticola* on tea: "It may be added that the discovery of a new root fungus on tea does not imply an increase in the gross amount of tea root disease in Ceylon, even if the fungus in question should be found alone, as it has been, on tea and even if it should be proved to be capable, as it may, of causing tea disease unaided. It means in this case that the *Rhizoctonia* has not been taken into account in the past and that its presence adds one more to the number of fungus agents causing or associated with root disease. The *Rhizoctonia* is thus to be regarded as a new agent, the full and real significance of which is not clear at the moment." The phrase "a new agent" may be improved to read "a newly-found agent," and I may add that further investigation of the conditions under which *Rhizoctonia bataticola* occurs has made clear its significance and has led, in fact, to the views which I hold now and which I enunciated at the Agricultural Conference in March (*Tropical Agriculturist* 68, p. 201, April, 1927). I may add that my views of the significance of the presence of the *Rhizoctonia* apply to all the plants attacked by the fungus and, further, that, despite the fact that "experienced mycologists" have not yet recorded the *Rhizoctonia* from other parts of the tropics, I see no reason for ceasing to expect the finding of it in regions other than those in which it has been found and studied, namely, Uganda and Ceylon. I refer particularly to its occurrences on woody hosts for, although

Rhizoctonia bataticola has been recorded as a parasite of herbaceous plants in India, Egypt and America in addition to Uganda and Ceylon, investigation of its woody hosts has been confined to the two last countries.*

The control of *Rhizoctonia bataticola* presents a difficult problem, but I believe it is a mistake to regard it as insoluble. Even if it proves to be insoluble, there will be no cause for alarm so long as the present field conditions which affect the fungus remain unchanged, and I see no reason why they should change in favour, so to speak, of *Rhizoctonia bataticola*. They are more likely to change in favour of the plant exposed to the *Rhizoctonia*. The introduction of the question of alarm is therefore unreasonable and unnecessary, and there are no grounds for the assumption that "the prospects of our main agricultural industries in Ceylon are anything but bright." From the point of view of *Rhizoctonia bataticola* the said prospects are unaffected. The introduction of the question of alarm can be merely to confuse the real issue. The latter is the question of the responsibility for root disease, a responsibility which, in my opinion, has been laid on the wrong shoulders and which should be transferred to *Rhizoctonia bataticola*.

Dr. Gadd proceeds to discuss the local treatment (trenching and stumping) of root disease which he attributes to *Fomes*, *Poria* and *Rosellinia* and the reasons for the adoption of the treatment. He asserts that it has been successful, and he concludes that "the success achieved by these methods has certainly justified their adoption." He also remarks that, "if the success of the treatment is admitted, the correctness of the principles on which it was founded is tacitly implied." He is understood to argue that the treatment has been so successful that the supposed diminution in the incidence of root disease which he mentions and which is accepted as a fact for the sake of argument has been due entirely to the treatment. He also implies that *Fomes*, *Poria* and *Rosellinia* must be causes of root disease on the ground that the treatment of their supposed outbreaks is successful in controlling their spread.

Dr. Gadd's argument and his conclusion regarding the parasitism of *Fomes*, *Poria* and *Rosellinia* hinge wholly upon his assertion that a certain treatment of root disease has been followed as a matter of course by a diminution of the amount of root desease, and his argument must fall to pieces and his conclusion be invalidated if it can be shown that his assertion regarding the success of the root disease treatment may be doubted. The first point against the said assertion is that it is founded on a basis of *post hoc ergo propter hoc* and that it possesses all the weaknesses of a *post hoc ergo propter hoc* proposition. When a certain act, say, trenching and stumping, appears to be succeeded by a certain result, say, diminution of root disease, it does not follow that the act and the apparent result are related in the sense that the former is, or must be, the cause of the latter or the latter the effect of the former. Between the cause and the apparent effect there is a gap which can be stopped effectively in only one way, namely, by proof of a connection between the cause and the apparent effect. Such proof is entirely lacking in the case under discussion, and the assertion of the success of the root disease treatment is nothing more than a mere statement on which legitimate doubt may be cast so long as the supposed connection between treatment and diminution of root disease is unproved. Apart from the fact that it is doubtful if all those who have practised the treatment would claim success for it, there will be no good reason for postulating a logical connection between the treatment and the diminution of root disease until control

* Information has been received recently from the mycologists of Burma and Southern Rhodesia that they have *Rhizoctonia bataticola* in their respective regions, but stress is not to be laid on the presence of the fungus in the countries mentioned until the identifications can be confirmed from specimens and isolations of the fungus.

experiments in trenching and non-trenching and in removal of stumps and debris and non-removal have demonstrated that trenching and stumping influence in any way the magnitude of a supposed outbreak of *Fomes*, *Poria* or *Rosellinia* disease; that is to say, when it is shown particularly that the lack of trenching and the non-removal of stumps and debris result in a greater loss than would be occasioned if trenching and stumping were performed. While there is no such proof of the efficacy of the treatment, it cannot be claimed that the treatment has led to a diminution of root disease, and the assertion that the methods of treatment are successful and that their success has justified their adoption are valueless. The deduction that *Fomes*, *Poria* and *Rosellinia* are causes of root disease because certain treatment has appeared to control the extent of their outbreak has nothing to commend it. Even if the treatment controls their spread, they may still be saprophytes or secondary fungi, but their parasitism is more doubtful than ever when it is shown that there need be no connection between their supposed successful treatment and the diminution of root disease. Again, Dr. Gadd has neglected to state that the diminution of root disease may be capable of explanation on grounds other than those he mentions, and it may be pointed out that the diminution is difficult of proof. It may also be doubted if all Ceylon agriculturists will agree that there has been a diminution of root disease. Another point is that the fungi supposed to be treated with success cannot be regarded as the basic causes of root disease until their parasitism has been proved. I am justified, therefore, in holding the opinion that the treatment only *appears* to be successful inasmuch as it may control the spread of secondary fungi like *Fomes*, *Poria* and *Rosellinia*, the habits of which, be it noted, enable them to kill off plants already attacked by *Rhizoctonia bataticola* more quickly than the slow-acting *Rhizoctonia* itself. The treatment has no effect upon the real cause of the disease, *Rhizoctonia bataticola*, and no good reason has yet been brought forward for departing from the hypothesis that the real cause of root disease was and is the hitherto unrecognised presence and parasitism of *Rhizoctonia bataticola* and that *Fomes*, *Poria* and *Rosellinia*, if present, were and are only secondary agents. I therefore continue to regard all the plants involved in an outbreak of root disease, whether large or small, as having been attacked in the first place by *Rhizoctonia bataticola*, and I hold that trenching and stumping are of little, if any, value as treatment of the outbreak because they do not affect in any way the incidence or the spread of the *Rhizoctonia*, a fungus which does not move from plant to plant by contact, does not spread through the soil by creeping mycelium and is widely distributed in Ceylon soils.

The value of trenching is severely limited. It may be used to confine secondary fungi to the area in which they first appear and in that way it may ward off their attacks on plants which are outside the area, but it must be understood that, attacked as they are by *Rhizoctonia bataticola*, all the plants of a given outbreak of root disease of, say, tea are doomed whether they are protected from the rapid effects of secondary fungi by their being outside a trench which limits the spread of the secondary fungi or whether they are exposed to the secondary fungi by virtue of their position inside the trench. In other words, trenching does not influence the magnitude of an outbreak of root disease though it may succeed in prolonging the life of attacked plants by protecting a proportion of them from secondary fungi,—a doubtful advantage. It should be noted that the facts that the rate of progress of the *Rhizoctonia* in individual plants may vary and that all diseased plants are not necessarily infected at the same moment may lead to an appearance in the field which suggests slow spreading of infection from plant to plant, and, further, that the attacks of secondary fungi like *Fomes*, *Poria and Rosellinia* may heighten the appearance of spreading of infection and cause it to appear to be rapid.

With reference to *Rhizoctonia* disease of rubber, it has been suggested by Mr. Roy Bertrand that trenching may be beneficial inasmuch as it may be used to prevent the roots of healthy trees from entering areas known to be infected by *Rhizoctonia bataticola*. The possible value of trenching in such a case must be admitted, but it is limited by the fact that the roots of neighbouring trees have been exposed in all likelihood to the attacks of the *Rhizoctonia* by their natural growth and spread in the soil before it is apparent that the area which they have entered is infected. Again, the roots which it is desired to protect may be infected already or may be resistant to the attacks of the *Rhizoctonia* or may not have come into contact with the fungus in the soil. In either case, the value of trenching carried out after *Rhizoctonia* disease has been found is problematic.

Stumping, again, may or may not be of value. As far as *Rhizoctonia bataticola* is concerned, it is of little value because the presence of stumps and debris has nothing whatever to do with the presence of the *Rhizoctonia* in the soil. It is probable that its wide distribution is accounted for in a totally different manner. In this connection it ought to be made clear that "stumps" does not include remains of plants killed by *Rhizoctonia bataticola*. In the case of *Rhizoctonia* disease of, for example, tea and rubber, the removal of all the roots, even the smallest, of diseased plants is advised on the ground that their decay *in situ* will liberate in the soil the numerous sclerotia or resting bodies of the fungus and so will ensure in time a greater exposure of the supply plant to *Rhizoctonia* attack than need be. As far as the secondary fungi, *Fomes, Poria* and *Rosellinia* are concerned, stumping may be useful as a means of removing their points of origin and so of controlling, in the manner explained above, the secondary damage they may do. Against this consideration it has to be remembered that *Fomes* and *Poria* may be found in areas where there are no stumps. They must therefore live free in the soil, and, while they can do so, stumping can have only a limited effect upon their presence or absence. Similarly, they may be present on stumps and cause no disease. In short, trenching and stumping may affect the apparent duration in time of an outbreak of root disease by prolonging the life of diseased plants in the manner described, that is by checking the activities of secondary fungi, but they can never affect the magnitude of the outbreak because they do nothing to control the true cause of the outbreak.

It has been shown that the success claimed for the root disease treatment is more apparent than real and that the assumed cause-and-effect relationship between treatment and diminution of disease is not proved and, in fact, is unlikely to exist. There is therefore no basis for Dr. Gadd's remark that "there appears to be some evidence indicating the accuracy of the old ideas, that *Fomes*, *Poria*, etc. are the active parasites." It has yet to be proved that their treatment has any connection with the diminution of root disease and that the fungi themselves are parasitic.

Another point which has a bearing on this discussion may be mentioned, namely, that the supposed absence of root disease of, say, rubber in certain regions is attributed to the fact that the areas planted with the crop contained no stumps or were cleared of them before planting was done; in other words, absence of root disease is attributed to lack of stumps. The absence of root disease, however, is only apparent. Occasional trees or small groups of trees die in the areas mentioned, and their loss is attributed to *Diplodia* dieback or to lightning or to unknown causes. It is suggested that an examination of the roots of such trees will disclose the fact that they have been attacked by *Rhizoctonia bataticola*, and I may add that I am confident of obtaining confirmation of this view.

I now take up Dr. Gadd's criticism of my reasons for holding that *Rhizoctonia bataticola* is *the* parasite and that other fungi which have been blamed in the past are secondary agents which cannot cause root disease of themselves and can attack only plants already attacked by the *Rhizoctonia*. Dr. Gadd's first point is an objection to my use of the phrase "sole association" applied to cases of root disease in which, as I put it with reference to *Rhizoctonia bataticola*, only one fungus occurs. He attempts to show that there cannot possibly be a case of "sole association" on the ground that, "as soon as a tissue has been killed by one organism, other organisms appear and sometimes so crowd out the original invader that the latter is difficult, almost impossible, to find," and, further, that "every diseased root bearing *Fomes* and *Poria* is accompanied by numerous other fungi besides *Rhizoctonia bataticola*", and that "no claim has ever been made or is likely to be made by an experienced mycologist that *Fomes*, *Poria*, or other parasitic fungi occur in sole association with frequent cases of root disease."

Taking his statements in the order in which I have quoted them, I would point out with reference to them that, first, the crowding out of the original invader, in this case *Rhizoctonia bataticola*, by secondary organisms does not take place, and, second, that I doubt if every diseased root bearing *Fomes* and *Poria* is accompanied by numerous other fungi besides *Rhizoctonia bataticola*, and, third, that, if the accounts of *Fomes* and *Poria* disease given by experienced mycologists do not claim, or at least imply clearly, that these fungi occur in "sole association" with frequent cases of root disease, the said accounts are extremely misleading.

Returning to the first point, I would call Dr. Gadd's attention to the following facts. The most striking symptom of *Rhizoctonia* attack on roots is a drying and hardening of both bark and wood which is perhaps more apparent in wood than in bark (and cortex) but which, nevertheless, affects both. This hardening does not encourage the growth of secondary organisms. Numerous isolations from both bark and wood of roots affected by *Rhizoctonia bataticola* have been made. In many cases, secondary organisms are absent; in others, their presence may be dismissed on the grounds mentioned later, namely, that they are of minor importance. Secondary organisms, if present, might be expected to develop in numbers on *Rhizoctonia*-infected roots kept in damp sand for months; they do not do so either in numbers of species or numbers of individuals. Many sections of root wood and bark containing *Rhizoctonia bataticola* have been made and examined, and the closest scrutiny of the sections under the microscope has failed entirely to disclose the presence of the mycelium or other parts of the numerous secondary fungi mentioned by Dr. Gadd. In fact, the only fungus of consequence which occurs more than rarely along with the *Rhizoctonia* on or in roots apparently affected by the *Rhizoctonia* alone is *Diplodia*, a fungus which is regarded as, and is being shown by experiments in progress to be, a very weak parasite if it is a parasite at all. When specimens of roots killed by *Rhizoctonia bataticola* are taken from plants which are sickly but not quite dead, that is to say, roots which are in the most favourable condition for examination into the cause of their death because secondary organisms have not yet invaded them or have not taken the complete possession of them mentioned by Dr. Gadd, they are found to be quite free of secondary organisms. It can be asserted at this point that, as far as *Rhizoctonia bataticola* is concerned, secondary organisms do not crowd out the fungus or render it difficult to find or to isolate.

With regard to the second point, that "every diseased root bearing *Fomes* and *Poria* is accompanied by numerous other fungi besides *Rhizoctonia bataticola*," this statement may be doubted because it has not

been found to be either relatively or universally true. To mention only the case of *Poria*, tea specimens can be found, the collar and the larger parts of tap and lateral roots and even the small roots of which are so closely covered with *Poria* mycelium that there is no room or footing for fungi other than the *Poria* itself and the one which may be found underneath the *Poria* because it penetrated the root before the *Poria* attacked it, namely, *Rhizoctonia bataticola*. Other fungi may possibly find an entry at a later stage, that is, when *Poria* has rotted the wood of attacked parts, but that fact does not affect my present argument. Again, if "every diseased root bearing *Fomes* and *Poria* is accompanied by numerous other fungi besides *Rhizoctonia bataticola*," which other fungi Dr. Gadd would insist on taking into account, it may be asked why the other fungi are not mentioned at least in, for example, Mr. Petch's account of, say, *Poria* root disease of tea in his "Diseases of the Tea Bush." It must be concluded that Mr. Petch did not see the numerous other fungi and that they were not present, or that, if he did note their presence, he did not think them worthy of mention.

The latter conclusion seems more likely to be correct, but it is unlikely that *Rhizoctonia bataticola* was numbered among the fungi which could be thus ignored. A point which Dr. Gadd has missed, a most important one, is that the fungi associated with a case of root disease, particularly of a woody plant, can be divided into two groups, major and minor. An experienced mycologist will have little difficulty in deciding on grounds of relative frequency of occurrence or degree of penetration or presence of regular symptoms which fungi shall be placed in one group and which in the other, and it seems as if Mr. Petch regarded the problem from this point of view when he wrote his account of, say, *Poria* disease of tea. It is evident that he thought that in this particular case *Poria* was the only fungus worthy of mention and of the responsibility for root disease among all the forms he found on diseased roots. This brings me to the crux of the matter, namely, that the words "sole association" are not used in an absolute sense. They are used in the relative sense which is implied in Mr. Petch's account of *Poria* disease of tea. It is justifiable to conclude from his account of *Poria* disease that he meant it to be understood that the fungus *Poria* was in "sole association" with the cases of root disease he attributes to its agency, and it follows that, contrary to Dr. Gadd's assertion, a claim has been made by an experienced mycologist that "*Fomes*, *Poria* or other parasitic fungi occur in sole association with frequent cases of root disease." I have mentioned already that I consider such an account of *Poria* disease of tea as that given by Mr. Petch to be misleading if it is not in order to conclude from it that *Poria* is claimed to be in "sole association" with the cases of disease which Mr. Petch associates with it. In concluding this part of the discussion, it may be pointed out that Dr. Gadd has produced no valid objection to my use of the words "sole association." I have attempted to make clear the sense in which they are used and I have shown that another mycologist has implied "sole association" in his description of a certain root disease taken as an example. It is justifiable, therefore, to continue to claim that *Rhizoctonia bataticola* occurs in "sole association" with cases of root disease and to refuse to believe in the parasitism of *Fomes*, *Poria* and other fungi until cases of their "sole association" with root disease in the sense that a certain major fungus, *Rhizoctonia bataticola*, is not present at the same moment are encountered. In other words, the words "sole association" may be used legitimately as a criterion of the pathogenicity of a given fungus.

Dr. Gadd objects to such a criterion, for he says "if we allow for the sake of argument that *Rhizoctonia bataticola* does occur alone, I still maintain that it constitutes no proof of parasitism." He then proceeds

to explain why he refuses to accept sole association as a proof of parasitism He says that small roots may die back from physiological causes and that *Rhizoctonia bataticola*, a fungus which is widely-distributed in our soils, enters them and takes up in them a saprophytic existence; in other words, it lives a non parasitic life in the dead roots. It is to be noted that he does not mention the possibility of its continuing its growth into larger parts of the roots and so passing from a supposed saprophytic to a parasitic condition. No matter in what state, saprophytic or parasitic, the fungus begins its life inside the roots of, say, a tea bush, it must become parasitic if it can be shown to advance and penetrate and permeate the roots or a proportion of the roots of the living plant. That it may and does do so is shown by specimens in my possession; in fact, if secondary fungi like *Poria* do not attack the sickly plant, the penetration will be complete enough to enable the fungus to permeate the above-ground main stem viâ the roots and to render the wood dry and hard after its characteristic fashion. My point is that such penetration and permeation as I have just mentioned, processes which can be shown to take place, constitute evidence of parasitism sufficient to satisfy an open-minded person. Such evidence has been accepted without question in the past, and it is difficult to understand why it should not be accepted in the case of *Rhizoctonia bataticola*. When penetration is accompanied by sole association, the evidence of parasitism is even more complete. If *Rhizoctonia bataticola* were the saprophyte that Dr. Gadd suggests it is and not the parasite that it is claimed to be, it would remain in the small dead roots which he says it may enter, and would not kill the plant by advancing in its tissues and interfering so seriously with its normal life as to lead to its eventual death.

It may be thought that the advance of *Rhizoctonia bataticola* from its first point of entry into the plant can be explained by saying that environment is at fault ; in other words that the plant must be in bad health to permit the fungus to make headway. Here another mistake would be made. The causation of fungus root disease may be regarded from two points of view which may be called the *immediate* and the *ultimate*. The immediate point of view considers the fungus or fungi which are actually found in association with root disease and decides which organism is responsible for the disease. The ultimate point of view, on the other hand, considers the causes, physiological or other, which enable the fungus to attack the plant ; in other words, it considers the question why there should be any root disease at all and endeavours to explain the conditions which enable a fungus to establish itself in the roots of a plant. These points of view are distinct from each other, and it may be insisted legitimately that this discussion is concerned only with the immediate point of view. The whole question at issue, namely, the responsibility of *Rhizoctonia bataticola* for root disease, is concerned only with the fungi which are associated with root disease and not with the reasons, physiological or other, why there should be such a thing as fungus root disease. To put the matter differently, the point is that *Rhizoctonia bataticola* is the fungus that enters by the smallest roots and so starts on a career which cannot be regarded as other than parasitic ; it is irrelevant to this discussion to introduce the question of the ultimate responsibility of environment for the presence of the *Rhizoctonia* in the root tissues of the plant.

One small matter remains before Dr. Gadd's next point is taken up. He talks of trees growing in infertile soil "such as is usually the case when rubber trees are affected by dieback." He means that rubber dieback (presumably *Diplodia* dieback) is due primarily to infertile soil conditions which so militate against the health of the tree that *Diplodia*, an acknowledged weak parasite, is able to attack it above ground and kill it to its base. I have announced elsewhere that I have found in all recent

cases of *Diplodia* dieback of rubber that the roots of the trees are affected by *Rhizoctonia bataticola*, and I assert that the *Rhizoctonia* is to be found in the roots of every tree affected by normal *Diplodia* dieback. I hold further that the root disease caused by the *Rhizoctonia* is a more satisfactory explanation of the ill-health and eventual death of the tree—in my experience, all dieback trees die eventually,—than the weak parasitism of *Diplodia*. But the point of this paragraph is that Dr. Gadd would explain the attack of *Diplodia* on the ground that the tree is so weakened by its being in infertile soil that *Diplodia* is enabled to attack successfully. Another explanation is that the tree is so weakened by *Rhizoctonia* root disease that *Diplodia* can attack it, and its claim may be based, first, on the fact that the penetration of the *Rhizoctonia* in the roots of dieback trees is so thorough and has gone so far that the fungus must be more than a mere saprophyte, and, second, on the fact that healthy trees in the neighbourhood of the dieback tree may be expected to feel the effects of the supposed infertile areas. That they do not do so is apparent in the field. Again, it is doubtful if it can be proved that every case of dieback is associated with infertile soil or that the converse, that dieback-affected trees are never to be found in fertile soil, is true.

Dr. Gadd attempts next to explain away the statement that, when more than one fungus is present in cases of root disease, *Rhizoctonia bataticola* is the fungus which is consistently present. The second fungus that may accompany it may be, to confine the list to the fungi mentioned by Dr. Gadd, *Fomes* or *Poria* or *Rosellinia*. He says that the *Rhizoctonia* is a saprophyte and that "the dead roots resulting from the attack of one of the established parasites form an excellent medium in which this common soil fungus can grow." Apart from the fact that such an interpretation ignores the facts of the case, its assumption that *Fomes*, *Poria* and *Rosellinia* are "established parasites" cannot be allowed to pass. Before these fungi can be regarded as "established parasites," two conditions at least must be satisfied. The first is that they must be shown to be in "sole association" (in the sense in which this phrase may be used) with cases of root disease; the second, that they must be proved to cause disease. The present position of *Fomes*, *Poria* and *Rosellinia* is that no one of them can fulfil one of these conditions, let alone both, and that their parasitism, resting as it does on mere assertion or on a supposed sole association with root disease which does not exist, is far from established. *Rhizoctonia bataticola*, on the other hand, has been proved by experiment to cause root disease in India, Egypt and Uganda, and will be proved, I hope, to cause it in Ceylon, and it can be shown to be in sole association with numerous cases of root disease. These facts cannot be ignored and therefore the claim made for the parasitism of *Rhizoctonia bataticola* cannot be set aside as easily as Dr. Gadd imagines.

The next matter for discussion is the claim that *Rhizoctonia bataticola* precedes in time of attack the other fungus, say *Fomes* or *Poria*, that occurs along with it. It is noted that Dr. Gadd does not object to the importance attached to priority of time of attack. The priority may be difficult to prove but that is no reason why it should not be attempted from both field and experimental sides. He takes one of my field pieces of evidence, a case of rubber root disease in which *Rhizoctonia bataticola*, found to be well-established at the first examination of the roots, was succeeded after a few months by *Fomes* (two species), *Ustulina* and *Diplodia*. My explanation is that the *Rhizoctonia* was the original parasite and that *Fomes*, *Ustulina* and *Diplodia* in this case followed it in time. I also hold that *Fomes*, *Ustulina* and *Diplodia* would not have been found on the roots at all if *Rhizoctonia bataticola* had not prepared the way for them. In other words, *Fomes*, *Ustulina* and *Diplodia* were in this case (as they are in all others, I

hold) of only secondary account. In the first place, I can assure Dr. Gadd in reply to his suggestion that *Fomes* might have been present at the first examination that the presence of *Fomes* was not overlooked. The first examination of the roots of the trees in question was conducted with care because the case was one of the first of *Rhizoctonia* on rubber roots. I had been surprised to find in plenty on roots sent to the laboratory with the first report of the disease a fungus which had never been recorded on rubber in Ceylon or any other country. In the second place, the degree of penetration of the roots by *Rhizoctonia bataticola* was incompatible with the idea that the *Rhizoctonia* was present only as a saprophyte. In the third place, Dr. Gadd says that "after such treatment (meaning the first examination) the presence of any soil fungus on the roots merits no comment." The question cannot be dismissed in this fashion. Perhaps I ought to have explained that at the first examination the trees were moribund and that at the time of the second examination their outward appearance had changed but little if at all and also that between the examinations the roots of the trees were not left exposed. No doubt the first examination disturbed the roots, but, even so, it could not have had any serious effect on the trees because the majority of the roots were already killed and permeated by the *Rhizoctonia* to points varying from three to six feet from the trunks of the trees. The treatment, therefore, does not explain the presence of the *Fomes*. In any case, it must be admitted that the *Fomes* was in this case a secondary or saprophytic fungus. That, after all, is the point of importance in the matter. The secondary nature of the *Fomes* also explains why, in the case of one tree in which all the roots had not been affected by the *Rhizoctonia*, the *Fomes* occurred only on those roots which had been attacked by the *Rhizoctonia*. Other cases of rubber disease in which no disturbance of the roots took place have shown *Rhizoctonia bataticola* well-established in the smaller roots and advancing into the larger roots and *Fomes* and *Poria* on the outside of the larger diseased roots, and I hold that the explanation of the situation as a case of parasitism on the part of *Rhizoctonia bataticola* followed by the entry of saprophytic or secondary organisms fits the facts in every case. Further, Dr. Gadd does not explain the presence of more than one of his supposed parasitic fungi on the roots of a single diseased tree whereas the preliminary parasitism of the *Rhizoctonia* is sufficient reason why secondary fungi should appear in numbers and at the points where *Fomes*, *Poria* and others are found.

I am glad that Dr. Gadd admits the assertion that *Rhizoctonia bataticola* enters the plant by the smallest roots. Out of the fact that *Rhizoctonia* does attack viâ the small feeding roots arise two points. The first is the claim that that method is "the most natural means of entry" into the host plant, and the second is that I hold that, having established itself in the smallest roots, *Rhizoctonia bataticola* then invades the root system (or part of it, for, in a given case, all the roots need not be parasitised) and advances, so to speak, onwards and upwards, always getting nearer the larger parts of the roots.

Dr. Gadd objects to my "most natural method of infection." It may be pointed out that we are dealing with soil fungi and root parasites and that the introduction of forms like *Pythium Debaryanum* and *Rhizoctonia solani* which attack at the surface of the soil is irrelevant to the question in hand. The introduction of the question of infection of the shoots of a plant is even more irrelevant because it implies an analogy between root infection and shoot infection which does not exist. The entry of *Rhizoctonia bataticola* into a plant by the smallest roots is regarded as the most natural means because it has been proved to be the means actually adopted by the *Rhizoctonia* and I shall believe that attack on a larger woody root is not only natural to but possible

for *Fomes*, *Rosellinia*, *Poria*, *Ustulina* and *Diplodia* when these latter fungi are proved to be able to penetrate the larger root without the help of a wound or without the help of another fungus which has weakened or killed the large root and so prepared the way for them. Until such proof of their natural attack on larger roots is forthcoming (experiments which attempt to show whether *Fomes*, *Poria* and other fungi can attack larger roots are in progress), it is legitimate to believe that entry by the small feeding roots is the most natural method for the fungi under discussion in this paper.[2] On these grounds the belief is more than mere opinion.

The next part of Dr. Gadd's criticism is a picture of a *Rhizoctonia* attack which is more fanciful than it need be, and is therefore misleading and inaccurate. He tries to make out that *Rhizoctonia bataticola* drops into a secondary position during its advance in the tissues of its host and that I have called in the aid of a toxin to help the fungus out of its difficulties. He says that the calling in of the toxin "affords a reason why *Rhizoctonia* is not to be found in the forefront of the attack." If he imagines that I have said or led him to understand that *Rhizoctonia bataticola* does not fight its own battles or lead its own attack, he is mistaken. *Rhizoctonia bataticola* enters the small roots, interferes at once with their water-absorbing functions, and proceeds to make its way into the larger roots and from the latter into the largest roots of all. It is perfectly apparent from the examination of numerous examples of *Rhizoctonia* disease that, if the fungus is left to itself, so to speak, it will continue to advance slowly but surely and to permeate all the roots it has entered until it reaches the collar of the plant, and it is further apparent that, in certain cases, of which tea (both old plants and seedlings) is one and *Grevillea robusta* is another it will be found eventually in the main stem of the plant in the form of hundreds of its sclerotia. Such cases of complete penetration and permeation are not uncommon. They are conclusive in their evidence that *Rhizoctonia bataticola* is primarily parasitic and that it does not occupy a secondary position. No other interpretation of its presence is possible. If *Fomes*, for example, was found in similar sole association with disease and was capable of being followed from its point of entry in its progress through the roots of the plant, there would be no hesitation in acclaiming it as a parasite. It is difficult to understand why similar recognition should be denied to *Rhizoctonia bataticola*.

In other cases, however, the harm done by the advance of the *Rhizoctonia* reaches a certain point, that is, it affects the larger roots. The larger roots feel, as it were, the advance of the fungus, and they begin to sicken. It must be remembered that, since the entry of *Rhizoctonia bataticola*, their supply of water and food materials has been interfered with. The general result is that they are rendered open to the attacks of other fungi that may be present in the soil. If the other fungi are absent, the *Rhizoctonia* advance goes on unhindered. If the other fungi are present, they may and often do attack the sick or weakened roots. It is in such a case and at such a time, and only then, that *Fomes*, *Poria* and company, the major secondary or saprophytic fungi, put in an appearance. They are unable to attack healthy roots, but they can attack unhealthy ones and they proceed to do so. By all accounts their growth is more rapid than that of the *Rhizoctonia*, and their entry upon the scene has the effect of hastening the otherwise slow death due to the *Rhizoctonia* alone, but their appearance does not mean that the attack of the *Rhizoctonia* ceases. In fact, it can be shown from specimens that it does not cease. In other cases, the *Rhizoctonia* can be shown to be well-established in a tissue before the secondary fungus appears on the scene. In either case, whether the *Rhizoctonia* remains in sole possession, so to speak, or whether it is aided eventually by secondary fungi, its original responsibility is unchanged,

and the idea that it occupies a secondary position and so requires the aid of a toxin to help it is absurd and totally unjustified. The suggestion that the *Rhizoctonia* kills in advance of its actual point of penetration with the aid of a toxin produced by itself was made as a possible explanation of the killing in advance and nothing more. Further, there is no objection to withdrawing in the meantime the suggestion that the fungus kills in advance of its actual point of penetration with the aid of toxin produced by itself, and it is to be noted that the essential facts of the case are unaltered. I hold that no unprejudiced person can examine a case of *Rhizoctonia bataticola* root disease without coming to the conclusion that the fungus advances from its point of entry onwards through the roots and kills as it goes. I may agree that I have offered less evidence on this point than on others, but I cannot agree that the evidence does not exist. It is only too plainly set forth in the field.

Dr. Gadd concludes his criticism by saying that the evidence which I have brought forward is insufficient "to establish the fact that the fungus *(Rhizoctonia bataticola)* is a parasite at all, and that the observed facts may be accounted for more simply on the basis that *Rhizoctonia bataticola* is nothing more than a common soil saprophyte." I have endeavoured, on the other hand, to show that the *Rhizoctonia* is a parasite and not a saprophyte, and I have criticised his reasoning and questioned his deductions. I have given reasons for my interpretation of the meaning of the universal presence of the *Rhizoctonia* in cases of root disease, and I hold that the reasons cannot be swept aside lightly. I hope it is only a question of time until the results of *Rhizoctonia* and other experiments will become available but I should like to remark that it is an established fact that successful infection of the host plant in experiment is often unattainable or very difficult to attain although the same infection occurs frequently in nature. Dr. Gadd's statement that "there should be little difficulty in reproducing at least some of the types of disease under laboratory conditions" may therefore be questioned. In fact, it is apparent both from experience in Uganda and attempts to reproduce *Rhizoctonia* infection in Ceylon that the conditions of laboratory experiments do not conduce to rapid infection. Meanwhile, it is unwise to ignore or brush aside such parts of the evidence as show that the presence of *Rhizoctonia bataticola* can be explained only on the ground that the fungus is a parasite.

One point remains, that of Dr. Gadd's classification of tea root diseases into three types according to their symptoms. His first two types, *Poria* and brown root, are founded on the symptoms induced by secondary fungi, and his third or *Diplodia* type corresponds closely in symptoms to disease caused by *Rhizoctonia bataticola*. Dr. Gadd has said that "it seems strange that brown root disease should crop up when solitary trees are to be finished off while *Poria* and *Fomes* occur only when a large patch has been prepared by the ravages of *Rhizoctonia bataticola* for slaughter." It is not universally true, however, that *Poria* and *Fomes* are confined to large outbreaks or patches of root disease. Both have been found on single plants attacked at different points in a field by *Rhizoctonia bataticola*. It is to be remembered that the *Rhizoctonia* may attack single plants situated at

different points in a field or groups of plants growing together, and that it is possible that the common appearance of *Poria* as a secondary fungus on tea or of *Fomes* on rubber may be explained on the ground that their growth is more rapid and their distribution greater than those of the fungus of brown root disease which appears less frequently.

Full descriptions of the three types of tea disease which began at the beginning, that is, with the first symptoms of disease, would be alike up to a certain point, and the first two supposed types would diverge from the third only when and because secondary fungi like *Poria* appeared and induced secondary symptoms, for example, the apparent rapid spread of *Poria*. This explanation is founded, of course, on the proved presence of *Rhizoctonia bataticola* in cases of root disease and on my view of the meaning of its presence, namely, that it is the primary parasite without the work of which the secondary fungi would be unable to attack, and I do not yet see any good reason for departing from my position in any respect. I am prepared, as I have said in another place, to believe in the independent primary parasitism of *Fomes*, *Poria*, *Rosellinia* and *Diplodia* when it is proved but not until it is proved.

Boga Medeloa.

MAHAWELLA.—Boga medeloa, if it is being used as a green manure, should be pruned at intervals before flowering. The reason for this is because in the formation of flowers and of seed there is a decided drain upon the food materials being absorbed and manufactured by the plant. The mineral portion of these food stuffs comes from the soil, and if this unnecessary drain on the food materials in the soil is to be avoided, pruning should be done just as flowering commences.

Young Boga making vigorous growth is affecting a considerable root spread, and with this root spread an increase in nodules containing nitrogen-fixing bacteria takes place. These nitrogen-fixing bacteria are capable of fixing the free nitrogen of the air and of making it available in complex organic compounds to the plant. If the aerial portion of the plant is incorporated in the soil an increase of nitrogen is effected and if the roots of the plants are broken up a further addition of nitrogen takes place. I am unaware of any records in the Tropics which show that leguminous crops do increase the nitrogen content of the soil unless the aerial portions are incorporated in it or unless the roots are broken in cultivation, but there is one record at Rothamsted, in England, that such an increase did take place during the growth of a crop of clover. The authorities there think that this was the direct result of growing the clover crop, but there is still some hesitancy on the part of other workers to accept this view. Leguminous crops can make use of nitrogen from the air and therefore causes less drain upon the nitrogen of the soil than other crops do. They are also generally deep rooting, and secure portions of their food supplies from layers other than those immediately on the top. Experiments have been begun to obtain data on various aspects of this question under tropical conditions and some results should be available shortly. In the meantime the Department is advising that leafy material and prunings of leguminous crops should be incorporated in the soil, either in trenches or behind forks during envelope forking. Young vigorous growing green manure crops are capable of greater nitrogen fixing than older plants, provided that soil and climatic conditions are equal.

This is not likely to occur unless the plants are allowed to flower and seed freely.

Desmodium forms rather a thick carpet. This Department has received reports which indicate that when this carpet becomes thick and dense some effect on growing crops (particularly young tea) is noticeable. If Desmodium is used or is allowed to grow, it is of importance that it should be forked through at intervals of time in order to improve aeration and in order to encourage deep rooting.

Report on Rubber Manurial Experiments, Experiment Station, Peradeniya, for 1926.

Old Manurial Experiment.

EACH plot consists of one double row of trees, the number varying between twenty-five and forty-two.

Manures were first applied in 1913. In 1916 slight alterations were made in the actual constituents of the mixtures but not in their general nature.

The following mixtures have been applied since 1916:—

The manures are applied in shallow trenches which are now dug one year down the middle of the double row, the next year across the rows between alternate pairs of trees, and the next year across the rows in the spaces not manured in the previous year.

It will be noted that a change in the manuring was made in 1923. In that year, and subsequently, the excess of phosphoric mixture which had hitherto been applied to rows 84 C and D, comprising the plot which had up to date given the highest yield per tree, was applied to rows 85 D and 86 A, comprising the plot which had hitherto given the lowest yield per tree

General mixture
Rows 83 B. and B.

				No. of lb. per acre annually
Supplying N	50 lb.	Sulphate of Ammonia	...	60
P_2O_5	30 ,,	Groundnut cake ...	...	200
K_2O	30 ,,	Blood meal ...	...	200
		Sulphate of Potash ...	...	75
		Steamed bone meal ...	...	136
			Total	671

Cost at present prices Rs. 52·83 per acre.

Excess of Nitrogen.
Rows 83 D and 84 A

Supplying N	80 lb.	Ground nut cake ...	...	182
P_2O_5	95 ,,	Steamed bone meal ...	...	43
		Blood meal ...	...	300
		Sulphate of Ammonia	...	150
				675

Cost at present prices Rs. 59·19 per acre.

Excess of Phosphoric acid.
Rows 84 C and D till 1923 then rows 85 D and 86 A.

Supplying P_2O_5	80 lb.	Groundnut cake ...	...	50
N	95 ,,	Steamed bone dust ...	...	200
		Basic slag ...	...	200
				450

Cost at present prices Rs. 22·09 per acre

Control (no manure and no cultivation).
Rows 85 A. and B.

Excess of Potash.
Rows 85 D. and 86 A till 1923 then rows 84 C. and D.

Supplying K_2O	80 lb.	Groundnut cake ...	...	136
N	95 ,,	Sulphate of potash ...	...	200
				336

Cost at present prices Rs. 23·98 per acre.

Since only one plot is allotted to each treatment the figures obtained do not admit of statistical treatment and the reliability of any conclusions arrived at is considerably lessened.

An attempt will be made in this report first to compare the behaviour of the manured plots with the control plot, and secondly to ascertain what effect, if any, the change in manuring in 1923 has effected.

Certain data are available on

1. Yield.
2. Growth, as indicated by girth.
3. Bark renewal.
4. Disease incidence and the general appearance of the trees.

For simplicity these aspects of the case will be dealt with separately.

Yield.

In table 1 the statements of yields have been divided into two periods—before and after the change in manuring.

In the first year, 1914, the yield from the control plot was the highest of all. During the period 1914 to 1923 however this plot dropped to the last place but one and the percentage increase in yield was the lowest of any plot. The same position of affairs is found at the end of 1926. The highest yield over the whole period has been given by the plot which received the excess of phosphoric acid mixture up to 1923 and thereafter the excess of potash mixture. This plot has given a total of 6 lb. 6 oz. per tree more than the control plot. At 100 trees to the acre this would represent 637 lb. per acre over the 13 years. At present prices the cost of the actual mixtures applied to this plot over the 13 years, together with the estimated cost of application, is about Rs. 360, so that with rubber at any higher price than 57 cents per lb. the application would appear to have been profitable. The next highest yield has been given by the excess of nitrogen plot. Here, at 100 trees per acre, an increase of 512 lb. over the control plot have been obtained. The cost of this mixture however over the 13 years together with application has been about Rs. 835, so that the price of rubber would have to be over Rs. 1·63 per lb. to make this application profitable.

Old Manurial Experiment.

Table I.—Average Yields Dry Rubber per Tree in lb. and oz.

PLOT	1914 to 1923 lbs. oz.	Percentage increase of 1923 over 1914	1924 to 1926 lbs. oz	Percentage increase of 1926 over 1923	Total 1914 to 1926 lbs. oz.	Percentage increase of 1926 over 1914	Increase over control for whole period lbs. oz
Rows 83 A & B General mixture	41 3	+ 133%	18 5	+ 21%	59 8	183 %	+ 2 10
Rows 83 D and 84 A Excess of Nitrogen	42 13	+ 121%	19 3	+ 15%	62 0	155 %	+ 5 2
Rows 84 C & D Original Excess of Phosphoric acid. Now Excess of Potash	43 9	+ 121%	19 11	+ 12%	63 4	156 %	+ 6 6
Rows 85 A & B Control (no manure.)	40 8	+ 65%	16 6	+ 26%	56 14	104 %	— —
Rows 85 D and 86 A Original Excess of potash, now excess of phosphoric acid	33 14	+ 80%	14 2	+ 31%	48 0	137 %	— 8 14

The general mixture plot has given an increase of only 2 lb. 10 oz. per tree over the whole period, or say 263 lb. per acre. The cost of this mixture and application has been Rs. 752 and this would not be profitable unless the price of rubber rose to over Rs. 2·98 per lb.

The application of the excess of potash mixture has been obviously a pure loss.

The change in manuring made in 1923 complicates our survey over the whole period but helps us, in some measure, to decide whether these increases over the control plots are due to manuring or are fortuitous. We find that up to 1923 Rows 84 C and D which received the excess of phosphoric acid mixture showed a larger percentage increase in yield than the plot which received the excess of potash mixture, whereas after 1923 the reverse is the case although the actual yield from the former plot from 1924 to 1926 is still higher than the latter. If then we accept this reversal of the order of percentage increase after 1923 as evidence that the yield has been affected by manuring we must come to the conclusion that with normal prices of rubber the annual application of 80 lb. of phosphoric acid per acre in the form of steamed bone-meal and basic slag has been profitable, but that none of the other mixtures have yielded a profit.

Growth.

The average girth and percentage increase in girth will be considered in the same manner in two periods. The average girths are of tapped trees only.

Here we find a plain indication that the application of manure has not influenced the rate of growth. The percentage increases in growth are very even and the unmanured plot is equal first with the excess of nitrogen plot.

The change in manuring in 1923 appears to have resulted in no change, the original excess of phosphoric acid plot showing a slightly higher rate of increase in girth both before and after the exchange of these two mixtures.

It is to be noted that in the control plot no trenches are dug and there is even a possibility that the fact that no periodical damage is done to feeding roots by cutting trenches has resulted in improved growth in this plot.

Table II.—Average Girths in Inches.

Plot	Jany. 1914 Inches	Jany. 1924 Inches	Percentage increase 1914—1923	Jany. 1926 inches	Percentage increase 1924—1926	Percentage increase 1914—1926
83 A &B General mixture	29·4	54·1	84	57·86	7	97
Rows 83 D & 84 A Excess of Nitrogen	29·7	55·6	87	60·87	9	105
Rows 84 C & D Original excess of Phosphoric acid. Now excess of potash	29·7	54·7	84	59·44	9	101
Rows 85 A & B Control	29·7	57·1	93	60·83	7	105
Rows 85 D & 86 A Original excess of potash. Now excess of phosphoric acid.	29·7	53·7	81	57·88	8	95

Bark Renewal.

Measurement of the renewed bark was made one inch from the top of the panel now being tapped. The bark thus measured was approximately one year and nine months old. The average thickness in millimeters is given below:—

General mixture	4·2
Excess of Nitrogen	4·7
Original Excess of Phosphoric Acid. Now Excess of Potash ...	4·4
Control	4·5
Original Excess of Potash. Now Excess of Phosphoric Acid ...	4·3

It is impossible to read any significance into these figures. The two plots showing the greatest average thickness of cortex, the excess of nitrogen and the control, are the same as those which have shown the greatest percentage increase in girth.

Disease Incidence and General Appearance.

The disease incidence is negligible and insignificant and there is no marked difference in the appearance of the trees.

The Avenue Rubber Manurial Experiments.

The plots used in this experiment consist of seven double rows or avenues, in which the trees are planted 15 ft. by 15 ft. with 40 ft. between the avenues. Manures were first applied in 1916 and tapping commenced in April 1922. There are three mixtures: in the first nitrogen is omitted, in the second phosphoric acid, in the third potash. These three mixtures are duplicated, but in one case lime is applied, in addition to the manures, at the rate of 8 lb. per tree, while in the other no lime is applied.

The control plot receives lime, but no manures. The manures are applied in the same manner as in the old manurial experiment, except the lime, which is broadcasted and disc-harrowed in usually about three weeks before or after the application of the manures. The number of trees per plot varies between 21 and 37. The various aspects of the experiment will again be considered separately.

Yield.

Here we find that the plot receiving lime only has given both the highest yield during the whole period and the highest percentage increase in yield. This control plot however is the end plot of the block and is surrounded on three sides by a drain and road at a lower level than the plot. Across this road is a plot of cacao, but this is lower than the rubber and the outer row of the plot certainly gets more light and air than any other plot. The conditions as regards drainage are also probably slightly superior. It is quite possible that this superiority of aspect has influenced the yield per tree. Moreover if we compare the average yield of the three plots receiving manures and lime with the average yield of the three plots receiving manures but no lime we find that these are equal—14·6 lb. per tree for the whole period in each case.

Avenue Rubber Manurial Experiment.

Treatments and Average Yields per Tree in lb. and oz.

PLOT	ANNUAL TREATMENT		Yield 1922, 9 months only.		Yield 1926		Percentage increase of 1926 over 1922	Total yield 1922—1926	
			lbs.	oz.	lbs.	oz.		lbs.	oz.
Control.	Lime only. 8 lbs. per tree		2	3	4	5	97	17	12
1	Superphosphate 138 lbs. per acre Sulphate of potash 147 „ „ „ Lime 8 „ „ tree	Nitrogen omitted	1	13	2	3	21	14	5
2	Nitrolim 277 lbs. per acre Sulphate of potash 120 „ „ „ Lime 8 „ „ tree	Phosphoric acid omitted	2	0	3	6	69	15	6
3	Nitrolim 277 lbs. per acre Superphosphate 138 „ „ „ Basic slag 147 „ „ „ Lime 8 „ „ tree	Potash omitted	1	12	2	14	64	13	7
5	Same manures as 1 but no lime		1	15	3	7	45	15	10
6	Same manures as 2 but no lime		1	14	2	15	56	14	5
7	Same manures as 3 but no lime		1	11	2	11	59	13	5

Although in the old manurial experiment we found the best yield given by the plot which, during most of its history, had received a mixture supplying an excess of phosphoric acid, in the case of the manured and limed plots in this experiment we find the best yield, and the greatest percentage increase in yield given by the plot which receives no phosphoric acid. Again in the old experiment the lowest yield was given by the plot which, during most of its history, had received the excess of potash mixture, whereas in this case, both with and without lime the lowest yields—though not the lowest percentage increase in yield—are given by the two plots which receive no potash. The smallest percentage increase in yield in this experiment is, both with and without lime, given by the plots from which nitrogen is omitted.

With these conflicting results the only safe conclusion is that in neither experiment has manuring affected yield and that such differences as exist are due to soil heterogeneity or to the uneven number of natural high yielders in the plots.

Here we find again that the outside plot, receiving lime only has shown a superior percentage increase in girth and bark renewal, but this might be ascribed to its position.

The average percentage increase in girth in those plots which receive manures and lime is certainly superior to those which receive manures but no lime but as shown this is not, in this case, accompanied by a superiority in yield, or any significant superiority in bark renewal—the average thickness of renewed cortex is 4·82 millimeters in the three plots receiving manures and lime and 4·78 in the three plots receiving manures but no lime.

Growth and Bark Renewal.

Plot and treatment.	Average girth, July 1916	Average girth, Jany. 1926	Percentage increase in girth, 1916 to 1926	Thickness of renewed cortex at point of measurement. Millimeters
Control and lime only	6·00	42·58	609	5·14
1. Manures and lime. No nitrogen	7·25	41·50	486	4·77
2. Manures and lime. No phosphoric acid.	6·85	40·52	637	4·57
3. Manures and lime. No Potash	7·04	42·11	483	5·11
5. Manures. No nitrogen	7·40	41·30	457	4·60
6. Manures. No phosphoric acid.	8·00	39·57	369	4·96
7. Manures. No potash	8·30	41·12	395	4·79

Incidence of Disease and General Appearance.

No significance can be attached to the disease incidence which is slight.

In the matter of general appearance the end row of the end plot certainly shows superior lateral branching, as would be expected. In other respects there is no visible difference.

T. H. HOLLAND,
Manager,
Experiment Station.

Progress Report of the Experiment Station, Peradeniya.

For the Months of January and February, 1927.

Tea.

AFTER nearly three weeks' drought the tea in the plots under *Indigofera endecaphylla* is looking on the whole well. There is a slight falling off in appearance but not more than is usual at this season.

A comparison of a year's yields since the tea came into bearing after pruning in March 1924 and March 1926 gives the following figures:—

Pounds of made tea per acre of 2,722 bushes in bearing calculated at 24·15 per cent of green leaf.

PLOTS	March 1924 to February 1925.	March 1926 to February 1927.
141 A	1,194	1,100
141 B	1,109	980
142 A	1,194	1,135
142 B	1,003	842
143 A	901	1,053
143 B	1,088	1,207
145	982	974
146 A	1,250	1,170
146 B	1,379	1,527
147 A	1,181	1,426
147 B	1,257	1,477
148 A	1,037	1,074
148 B	959	839
149	1,426	1,440
Average per acre	1,158	1,160
Rainfall inches.	100·34	95·85

It will be observed that in 1926-27 seven plots show an increase over 1924-25, and seven plots show a decrease, while the average yield per acre is practically identical. When it is considered that the rainfall in 1926-27 was less than in 1924-25 it is certainly indicated that the presence of the *Indigofera endecaphylla* has not depressed the yields of tea. In this instance then the reduction in the cost of weeding and the practical elimination of soil erosion—which should in time result in increased yields—has apparently been obtained without any corresponding loss.

In plot 166, where gliricidia cuttings, planted in approximate contour lines, have now come on well, the dadaps, which were poor specimens, have been dug out.

A new system of roads and steps has been constructed in the Hillside tea, linking up the two sets of soil erosion experiment plots. No roads existed in this area.

The Hillside tea was manured in January with a complete mixture of artificials at the rate of 3 cwts. per acre.

Rubber.

In the trees in the individual yield plots which were pollarded in November, 1926 very few shoots had appeared by the end of January and a further number of branches of the same trees were pollarded early in February.

The holing of plot 174, the newly cleared plot of 3¼ acres for budded rubber, was almost completed by the end of February. About half the end which is covered with illuk was forked before the dry weather stopped this work, and in the remaining half lanes were forked out to enable holing to proceed.

Girth and thickness of renewed cortex measurements, as well as a census of diseased trees, were taken in all plots under experiment.

A systematic collection of bark samples for counting of rows of latex vessels by the Assistant Mycologist was commenced in February.

Cacao.

Lopping of Dadap shade was completed in February and Cacao pruning was about half completed by the end of that month.

Coconuts.

Of the 38 surviving Dwarf coconut plants planted from F.M.S. nuts in November, 1920, only one palm has flowered to date, so that the alleged early bearing capacity of this variety has not materialised.

The young palms of different varieties planted in the fodder grass plots were manured with a mixture of groundnut cake, blood meal, whale guano, superphosphate, sulphate of potash and sulphate of ammonia.

Fodder Grasses.

Favourable reports have been received of the growth of Napier grass, *Pennisetum purpureum*, at elevations up to 6,000 ft. This grass, which gives much heavier yields than the *Paspalum dilatatum* commonly grown at elevations where guinea grass will not thrive, appears to fill a long felt want.

Green Manures and Cover Crops.

150 lb. of *Indigofera endecaphylla* seed has been collected from the tea plots and several hundreds of pounds more can be collected. Estates requiring seed should book early.

Seed of *Tephrosia vogelii* was sown in two different plots in 1924. In one plot in poor soil at the Bandaratenne end of the station the plants seeded and died after one year and three months. In the other plot, where soil conditions were good and the growth superior, the plants died out in 2 years and 3 months, after yielding two crops of seed. Another plot is being kept periodically lopped. It would appear that this plant is much more sensitive to soil conditions and environment than *Tephrosia candida* and cannot in most cases be recommended as a substitute.

A plot of *Tephrosia candida* yielded at the rate of 21,000 lb. of green material per acre in 3 loppings in 1926. The same plot yielded 22,572 lb. per acre in 4 loppings in 1925. Most of the plots in the green manure experiments described in the report for September and October, 1925, are now well established. The first samples, after the planting of the green manures, were taken at the end of February, 1927.

Soil Erosion Experiments.

It has been decided, principally in order to obtain a better planting season for the cover crops, to take the initial year's records in area A from June 1st, 1926, to May 31st, 1927. The 1926 figures, however, may be quoted for general interest. It was found that from all six plots together an amount of dry soil was lost equal to 22 tons per acre or approximately ·52 cubic feet. This is equal to a loss of ·17 inches of soil over the whole surface of the ground.

Miscellaneous.

An area of approximately 4½ acres, lying between the six-acre coffee field and the Hillside rubber, has been cleared and partly terraced for the planting of *Taraktogenus Kurzii* and *Hydnocarpus Wightiana*, two plants utilised for the production of Chaulmoogra oil. The terraces are 6 ft. wide and sloped back into the hill at an angle of one in five. *Indigofera endecaphylla* has been planted over the banks of the completed terraces and three gliricidia cuttings have been put in round each hole.

Twelve grape fruit plants of three varieties arrived from America in February and were planted in the fruit plots. The percentage of survivals cannot yet be stated.

T. H. HOLLAND,
Manager,
Experiment Station,
Peradeniya.

Progress Report of the Experiment Station, Peradeniya.

For the Months of March and April, 1927.

Tea.

DURING March the manuring programme was carried out for the first time since a thick cover of *Indigofera endecaphylla* has been in possession of the ground.

The manures were, as usual, applied in alternate rows and the method employed was to make a vertical cut with a grass knife in the rows to be manured and rake away the creeper to both sides with mamoty forks. The cutting was done by men and the raking by women.

The operation cost Rs. 4·75 per acre. Manures were then applied in the normal manner after which the creeper was replaced by hand at a cost of Rs. 1·53 per acre. The latter operation certainly hastened the formation of a fresh cover, although a good deal of the growth that had been dragged back was dead. It could however be dispensed with, since a new cover would be formed in a comparatively short time by the creeper growing over from the undisturbed rows, and by fresh growth from the roots left in the middle of the rows when the creeper was dragged back.

The soil under the creeper was covered with decaying leafy matter and was in a nice friable condition, very superior to neighbouring clean weeded plots.

The severe drought in April resulted in the death of a few young supplies.

Rubber.

The shoots from the six pollarded best yielders in the individual yield plots were thinned to four shoots per branch. The growth from the pollarded branches has not been good.

An examination was made in April of the trees under the "Brown Bast Exhaustion Theory Experiment." The results will be included in the report on tapping experiments for 1926 to be submitted at the July meeting.

The manures were applied in the two manurial experiments in March.

All rubber drains were cleaned.

Holing in plot 174 for budded rubber was completed in April. It has not yet been possible to complete the eradication of illuk in this plot and lanes had to be cut through the illuk to complete the holing.

Cacao.

A round of pruning was completed in March and since then all canker has been treated by light scraping and painting with 10 per cent. Brunolinum Plantarium in part of the area and 10 per cent Agrisol in the remainder. The average yield per acre of good and black cacao from all plots for the cacao year ending March 31st, 1927, was 5·03 cwt. per acre. The yield for 1925-26 was 5·45 cwt. per acre and for 1924-25, 3·10 cwt. per acre.

A manurial experiment is to be started in 1927-28 in selected plots of which the yields have been recorded since the termination of the last manurial experiment in 1921.

Coffee.

An application of a complete mixture of artificials to the three plots planted with Robusta varieties in the six-acre coffee field, and of cattle manure to the three plots planted with Arabian coffees, had to be postponed till the end of April since cultivation was impossible during the drought.

The Systematic Botanist has commenced an examination of the characters of the different types of Robusta and other coffees growing on the station.

Green Manures and Cover Crops.

Calopogonium mucunoides sown in the New Avenue Rubber had germinated well but was almost entirely destroyed by snails. This plant seems to be one of the favourite forms of food of these pests.

In the green manure experiments previously described the *Crotalaria anagyroides* was cut and buried in for the first time. The plants were just flowering. The growth of this plant has been very much more rapid than that of *Tephrosia candida* which is not nearly ready for cutting yet.

Curry Stuffs.

A crop of ginger was harvested in March. The crop from ¼ acre was 1,296 lb. and this was divided into three equal lots. One lot was cured by the normal Ceylon method, the second lot by a Jamaica method which involved peeling the rhizomes, and the third lot was kept uncured. The whole crop was grown at a loss, but of the three above lots the greatest loss was incurred by the Jamaica curing since this peeled ginger fetched the same price as the unpeeled Ceylon cured ginger though the cost of curing the former was very much higher.

A crop of turmeric was also raised and cured by two different methods.

This crop has not yet been sold.

Miscellaneous.

Draw-bar tests with a number of ploughs and cultivators, both in dry land and in paddy fields, were carried out in co-operation with the Economic Botanist. The results will be published in the *Tropical Agriculturist.*

The terracing and holing of the area cleared for the growth of Chaulmoogra oil producing plants was completed.

The usual dislocation of labour was caused by the Sinhalese and Hindu new year, one-third of the labour force being absent for a full week.

Anchylostomiasis treatment was given to the whole labour force at the end of April.

The rainfall for March was 5·37 inches and for April 4·85 inches.

T. H. HOLLAND,
Manager,
Experiment Station,
Peradeniya.

Pure Line Paddy Competitions.

Harispattu and Yatinuwara Divisions, Kandy District, Maha 1926-27.

A PURE Line Paddy Cultivation Competition was organised during the Maha Season of 1926-27 in the Katugastota area and covered parts of Harispattu and Yatinuwara.

The following types of Pure Line Paddy which have done well in the district were grown:—B 11 and B 12.

24 paddy cultivators entered for the competition. The largest area cultivated by any one competitor was 2 acres and the smallest ½ acre.

Each field entered for the competition was inspected at different stages and at least three visits were paid, though in many cases several inspections were made. Careful notes were kept and marks were awarded for (1) general cultivation, cleanliness of surroundings, and evenness of sowing and planting, (2) freedom from and control of weeds and pests, (3) evenness of crop and (4) yields.

Of the 24 competitors three obtained yields of over 50 bushels per acre from B 11 type of paddy. In the case of the prize-winners they obtained yields of 63 1/3 and 56 3/5 bushels per acre respectively. The third cultivator got 26·3 bushels from his ½ acre or 52 3/5 bushels per acre. The average yields from village paddy in this section or area during the season were between 40 and 50 bushels. In one case 52 bushels were obtained.

In the other section where the cultivators grew B 12, 4 of the competitors obtained yields of over 40 bushels per acre; 8 had between 35 and 40, 3 had between 30 and 35 and 4 had 26 to 28 bushels per acre. The average yield in this locality this season was 30 to 35 bushels per acre. Compared with previous years, the yields this season were poorer due to unusual rains during the flowering stages of paddy.

The following were adjudged winners:-

Harispattu.—P. Ranhamy of Kondedeniya; extent cultivated ½ acre; obtained 114 points out of a possible 150 points. **1st Prize Rs. 45·00.**

Paranagama Kirihamy of Hapukote; extent cultivated 1 acre; obtained 108 points. **2nd Prize Rs. 20·00.**

Yatinuwara.—M. Kiriukkuwa of Mavilmada; extent 3/5 acre; obtained 130 points out of a possible 150 points. **1st Prize Rs. 45·00.**

S. Pinahenaya of Siyambalagastenne; extent 3/5 acre; obtained 128 points. **2nd Prize Rs. 20·00.**

The prizes and the departmental certificates have been awarded to the respective prize-winners.

Rubber Research Scheme, Ceylon.

Consequent upon the departure of Mr. J. Mitchell on six months' leave it is hereby notified for the information of all Subscribers to the Ceylon Rubber Research Scheme that the Secretarial work at Peradeniya will be carried out by Mr. M. Park and that inspections of estates will be divided during this period between the Technical Officers of the Scheme—Messrs. O'Brien and Taylor.

All applications for visits to estates or factories should be addressed as in the past to the Secretary, Rubber Research Scheme, Peradeniya.

Meetings, Conferences, Etc.

Board of Agriculture.

Minutes of a Meeting of the Board of Agriculture held in the Board Room of the Department of Agriculture, Peradeniya, at 11-30 a.m. on Thursday, March 10, 1927.

His Excellency the Governor, President of the Board of Agriculture, presided.

The following members of the Board of Agriculture were present:—Mr. W. A. Amarasekera, Kachcheri Mudaliyar; Sir Solomon Dias Bandaranaike, K.C.M.G.; Messrs. H. W. Roy Bertrand, C. W. Bibile, Ratemahatmaya; I. L. Cameron; the Chairman, Low-country Products Association; the Chairman, Planters' Association of Ceylon; the Agricultural Chemist; Messrs. J. B. Coles; Allen Coombe; R. G. Coombe; R. Copland; H. L. De Mel, C.B.E., Wace de Neise; C. A. M. de Silva; G. Robert de Zoysa; C. E. A. Dias; the Director of Agriculture; the Director of Irrigation; the Divisional Agricultural Officer, Central; the Divisional Agricultural Officer, Southern; the Divisional Agricultural Officer, Northern; the Divisional Agricultural Officer, North-Western; Mr. C. Drieberg; the Economic Botanist; the Entomologist; Messrs. H. W. Fitzpatrick; R. P. Gaddum; C. B. Herat, Kachcheri Mudaliyar; I. Horsfall; Hew Kennedy; the Hon. Mr. A. Mahadeva; the Manager, Experiment Station, Peradeniya; the Hon. Mr. T. B. L. Moonemalle; Mr. S. Muttutamby, District Adigar; the Mycologist; Messrs. T. B. Panabokke; S. Pararajasingham; J. S. Patterson; Gordon Pyper; W. A. Samarasinghe, Atapattu Mudaliyar; J. W. Scott; the Secretary, Rubber Research Scheme; Messrs. N. D. S. Silva; A. T. Sydney Smith; J. H. Titterington; G. O. Trevaldwyn; A. A. Wickramasinghe; and J. I. Gnanamuttu (Secretary).

Visitors.—Messrs. J. Fergusson, G. B. Foote, J. C. Haigh, A. J. Hamilton-Harding, John Josef, J. W. Oldfield, and J. Carson Parker.

His Excellency the Governor, in opening the session, observed that that was the first meeting of the Board of Agriculture as now reconstituted. He expressed his appreciation of the public spirit shown by the gentlemen who had consented to serve upon the Board. He was sorry that circumstances had prevented the attendance of the Members of the Legislative Council, who had to be present that day at an exceedingly important meeting of Council.

Agenda Item No. 1.—Confirmation of Minutes of Meeting held on October 20, 1926.

The minutes of the meeting of the Board held on October 20, 1926, having been printed and circulated, were passed and confirmed.

Agenda Item No. 2.—Election of Committees.

The Director of Agriculture proposed the election of Committees as per list, which had been printed and circulated for the consideration of the Board, and stated that any additional names to the Committees would be welcome. Since the printing of the list he had been asked to add the names of Messrs. Wace de Niese and C. A. M. de Silva to the Food Products Committee.

Mr. C. E. A. Dias seconded the adoption of the names proposed.

Mr. A. T. Sydney Smith proposed the addition of the name of Mr. L. A. Wright to the Estates Products Committee. This was seconded by Mr. Allen Coombe.

The Director of Agriculture stated that Mr. L. A. Wright was not a member of the Board of Agriculture as now constituted, but undertook to put forward his name for the next vacancy.

The following Committees were unanimously elected :—

Executive Committee.

His Excellency the Governor, President
The Hon. the Colonial Secretary, Vice-President
The Hon. the Controller of Revenue
The Director of Agriculture
The Hon. Sir H. Marcus Fernando
The Hon. Mr. D. S. Senanayake
The Hon. Sir James Peiris
The Hon. the Member for the European Rural Electorate
The Hon. Mr. A. Mahadeva
The Chairman, Planters' Association of Ceylon
The Chairman, Low-country Products Association
Mr. W. Coombe
Mr. R. G. Coombe
Mr. C. E. A. Dias

Ex Officio Members.

The Government Agent, Western Province
The Government Agent, Central Province
The Government Agent, Southern Province
The Government Agent, Northern Province
The Government Agent, North-Western Province
The Director of Irrigation
Mr. J. I. Gnanamuttu (Secretary).

Estates Products Committee.

The Director of Agriculture, Chairman
Sir S. D. Bandaranaike, K.C.M.G.
Mr. H. W. Roy Bertrand
Mr. E. Maberley Byrde
Mr. D. S. Cameron
Mr. I. L. Cameron
The Chairman, Low-country Products Association
The Chairman, Planters' Association of Ceylon
The Agricultural Chemist
Mr. J. B. Coles
Mr. Allen Coombe
Mr. R. G. Coombe
Mr. W. Coombe
Mr. H. L. De Mel, C.B.E.
Mr. Wace de Niese
Mr. Chas. A. M. de Silva
The Hon. Mr. W. A. de Silva
Mr. G. Robert de Zoysa
Mr. C. E. A. Dias
Mr. J. D. Dunlop
Mr. C. C. Du Pre Moore (on leave), Mr. R. Copland (acting)
The Entomologist
The Hon. the Member for the European Rural Electorate
The Hon. Sir H. M. Fernando
Mr. W. H. Fitzpatrick
Mr. R. P. Gaddum
Mr. H. D. Garrick
The Government Veterinary Surgeon
Mr. H. V. Hill
Mr. J. Horsfall
Mr. Hew Kennedy
The Hon. Mr. A. Mahadeva
The Manager, Experiment Station, Peradeniya
The Mycologist
Mr. T. B. Panabokke
Mr. G. Panditasekera
Mr. S. Pararajasingham
Mr. J. S. Patterson
The Hon. Sir James Peiris
Mr. Gordon Pyper
Mr. A. E. Rajapakse, Gate Mudaliyar
Mr. J. W. Scott
The Secretary, Rubber Research Scheme
The Hon. Mr. D. S. Senanayake
Mr. N. D. S. Silva
Mr. A. T. Sydney Smith
Mr. J. H. Titterington
Mr. G. O. Trevaldwyn
Mr. E. C. Villiers
Mr. T. H. Holland (Secretary)

Food Products Committee.

The Director of Agriculture, Chairman
Mr. W. A. Amerasekera, Kachcheri Mudaliyar
Mr. J. H. Armitage
Mr. C. W. Bibile, Ratemahatmaya
Mr. J. A. M. Bond
Mr. H. L. De Mel, C.B.E.
Mr. Wace de Niese
Mr. C. A. M. de Silva
The Hon. Mr. W. A. de Silva
Mr. G. Robert de Zoysa
Mr. C. E. A. Dias
The Divisional Agricultural Officer, Central
The Divisional Agricultural Officer, Southern
The Divisional Agricultural Officer, Northern
The Divisional Agricultural Officer, North-Western
Mr. C. Drieberg
The Economic Botanist
The Hon. the Member for the European Rural Electorate
The Hon. Sir H. M. Fernando
The Government Veterinary Surgeon

Mr. G. A. Gunatilleke, Kachcheri Mudaliyar
Mr. C. B. Herat, Kachcheri Mudaliyar
Mr. Harry Jayawardene, Gate Mudaliyar
The Hon. Mr. A. Mahadeva
The Hon. Mr. T. B. L. Moonamale
Mr. Candapper Muttyah, J.P.
Mr. S. Muttuthamby, District Adigar
The Hon. Mr. F. A. Obeyesekere
Mr. T. B. Panabokke
Mr. S. Pararajasingham
Mr. Edmund Peiris, Mudaliyar
The Hon. Sir James Peiris
Mr. A. E. Rajapakse, Gate Mudaliyar
Mr. M. S. Ramalingam, Kachcheri Mudaliyar
Mr. W. A. Samarasinghe, Atapattu Mudaliyar
Mr. P. Saravanamuttu, Assistant Government Agent
The Hon. Mr. D. S. Senanayake
The Hon. Mr. M. M. Subramaniam
Mr. T. Walloopillai
Mr. A. A. Wickramasinghe
Mr. N. Wickramaratne, Mudaliyar (Secretary)

Agenda Item No. 3.—Consideration of Report of Special Committee on the Further Extension of the Work of the Department of Agriculture.

The Director of Agriculture gave an outline of the report which had been printed and circulated. At the request of Unofficial Members of the Legislative Council, he had submitted certain proposals which were contained in Sessional Paper XXIII. of 1926. The present Sub-Committee, consisting of the Director of Agriculture (Chairman), the Hon. Sir James Peiris, the Hon. Mr. D. S. Senanayake, the Hon. Mr. W. A. de Silva, Messrs. Geo. Brown, R. G. Coombe, N. D. S. Silva, and Gate Mudaliyar A. E. Rajapakse, was appointed by the Board of Agriculture on October 20, 1926, to report on the further extension of the work of the Department for the consideration of the Board. A full account of the proceedings of the Committee had been appended to the report. The main proposal was an administrative one, namely, that the officers working in the various divisions should be so co-ordinated that they could deal with all agricultural matters in those divisions, and that the research staff at Headquarters should advise the divisional officers and also those agriculturists who seek their assistance direct. The Committee emphasized the need of conferences, even of divisional conferences, to push on and encourage the small cultivator, facilities for visits to experiment stations, including free travelling to members of co-operative societies, the use of the cinema to deal with special subjects such as rubber budding, treatment of diseases, selection of seed paddy, &c. The addition of agricultural stations was the main feature of the proposals. The Finance Committee had already considered the proposals in respect of two divisions and voted funds for agricultural stations for the Southern and North-Western divisions. A scheme of practical training would also be started at these stations. He emphasized the necessity at headquarters of further land for paddy experiments. Thirteen acres should be leased adjoining the Experiment Station, Gannoruwa, and provision would be included in the draft estimates for the next financial year in the same way as for the other new proposals in the report.

His Excellency the Governor invited comments, adding that the report was a very important one.

Mr. N. D. S. Silva proposed the adoption of the report. He stated that it gave him great pleasure to commend the report to the meeting. We felt that for the future prosperity of the country the co-ordination of the work of the different branches of agriculture was necessary, as it would tend not only to bring all classes engaged in agriculture together, but also give an opportunity to students to learn the cultivation of the product. The whole report is based on the memorandum written by the Director of Agriculture in 1917. A perusal of that document is really worth one's while. You will remember, Sir, that when the Coconut Research Scheme came before the Legislative Council, the Members gave it a hasty and indecent burial. I as Chairman of the Low-Country Products Association then, aranged for a conference with the members of the Legislative Council, Mr. Stockdale and the general public and discussed the subject at length. We felt that if any specialisation was necessary for any one particular branch that must be a subsequent development and an off shoot of our scheme. We consider that the climatic condition of different parts of the Island differ from one another and there-

fore the crops and the cultivation necessary for the different crops is different in each district. What may be grown profitably in one district may hot be profitable in another district, so that it is necessary to divide the island into areas according to the climatic conditions, if any particular cultivation requires special attention in any district that could be given at the proposed sub-stations to be established in the future. I feel that if this scheme is adopted and carried out it will be a step in the right direction and will be of great benefit to the country. I have much pleasure in proposing the adoption of the report of the Committee.

Mr. George Brown, in seconding the adoption of the report, laid emphasis on the growing and marketing of fruit, and on the cinematograph as a means of teaching the village cultivators at first hand what the various pests were, as well as the rudiments of botany.

Mr. R. G. Coombe regretted that owing to ill-health he had not been able to help in the completion of the report. It, however, had his support. He also emphasized the importance of fruit cultivation in this Colony, which enjoyed the reputation of being able to grow fruit of all kinds.

Mr. H. L. De Mel asked whether the Committee had considered at all the question of the resuscitation of the Coconut Research Scheme as put forward by the Low-country Products Association two years before.

The Director of Agriculture stated that the Legislative Council had desired that they should proceed with village agriculture, and proposals had been drafted on the understanding that the first thing that should be provided for was the machinery required for the development of peasant agriculture and the education of villagers in agricultural matters. The question of the Coconut Research Scheme was, therefore, not considered in the present instance. He sincerely hoped that the coconut industry would not allow it to remain where it was at the present time.

Mr. H. L. De Mel stated that, without raising a note of discord, he felt very strongly, as one interested in the growing of coconuts, that a report such as that should not be adopted without the Coconut Research Scheme being given the prominence that it deserved. He proposed the following rider:—

That the recommendations made in the report for research work in coconuts are totally inadequate and that this meeting is of the opinion that at an early date the Coconut Research Scheme should again be brought forward.

He added that such a scheme should be under the control of a Committee, with the Director of Agriculture permanently as its Chairman.

Mr. Robert de Zoysa seconded the rider, and promised every support on behalf of the Low-country Products Association.

Mr. J. S. Patterson supported, and said that the Coconut Research Scheme was most necessary, especially as the number of diseases was increasing.

Mr. C. E. A. Dias said that the black beetle disease accounted for a loss of about one million rupees in a year. He emphasized the need of a seed garden, as one had to wait for seven years to note results in the case of coconut.

The Hon. Mr. Mahadeva stated that it was not correct to suppose that the Legislative Council failed to appreciate the importance of coconut research. At the moment the excellent proposals now put forward were of more urgency, and should precede a Coconut Research Scheme. He thought that the present proposals contemplate a sort of Coconut Research Scheme in the North-Western Division. Funds were already allotted for 200 acres, part of which would go to the consideration of coconut problems. He thought that the Coconut Research Scheme should be duplicated in the different parts of the Island with experiment stations, unlike the Rubber and Tea Research Schemes.

The Director of Agriculture explained that the experiment station for the North-Western Division would devote attention

mainly to coconuts. The proposal was to purchase an estate of 80 acres at Wariyapola and to secure another 100 acres of adjoining land for early planting, so that the agricultural side of coconut cultivation could be dealt with satisfactorily. There was no provision for additional research officers. Additional staff was required for coconut research, and, if that was approved, the matter should be put before the Finance Committee as a definite and complete proposal.

Mr. Wace de Niese stated that a scheme on the lines of the existing schemes for rubber and tea was what was being clamoured for.

Mr. R. G. Coombe explained, in regard to tea research, that the intention was to start with one central station, and follow this up with the establishment of three sub-stations.

His Excellency the Governor, in concluding the discussion, reiterated what he had said in various parts of the country, that he was not in a position to make promises for the reason that he could not implement them. The constitution now placed financial responsibility in the hands of the Legislative Council. He was, however, not precluded from stating the strong opinions that he held on any matter of public importance. The only service that he could do to the country at the present time was to give it the benefit of any experience that he had contrived to accumulate during a rather long service in His Majesty's Tropical Empire. He personally felt quite as strongly as Mr. De Mel that a research scheme for coconut was of great urgency. That opinion was confirmed by the recent report of the Imperial Economic Committee on marketing and preparing for the market produce in the oversea parts of the British Empire, in which occurs the following passage:—

"The question of the establishment of a special coconut research scheme is under discussion in Ceylon. This scheme was agreed to by the Government in 1924, but the Legislative Council found itself unable to provide the necessary funds. The advantages to be derived by the local industry from a scheme of this character are obvious, and we hope that progress with this scheme may yet be found possible."

Words from such an authority deserved attention and consideration. He regarded research in all agricultural matters as of the greatest importance. If there had been adequate research in the early days of the coffee industry, the great calamity of 45 years ago might have been at least mitigated. In the case of an industry like the coconut industry, occupying an area in this Colony of 900,000 acres, it seemed sheer folly to postpone any steps that would ensure its continuance. The Colony was in a very sound financial position. While respecting the desire of the members of the Legislative Council to foster its resources, he did not think that money standing at interest in investments would profit the Colony more than if it were voted for a really scientific research scheme. He recommended that the meeting should accept the rider, and instruct the Secretary to forward to the Colonial Secretary for submission to the Legislative Council the resolution, and ask for an early reconsideration of the decision which had been recorded in 1924.

His Excellency congratulated the Committee upon the very efficient way it had carried out its work, and upon the very practical suggestions it had put forward. He noted with pleasure that the Chairman of the Planters' Association was associated with the ex-Chairman of the Low-country Products Association in proposing that the report should be adopted.

The report was adopted unanimously.

Agenda Item No. 4.—Consideration of a Circular Despatch from the Secretary of State for the Colonies on the Marketing and Preparing for Market of Fruit in the Oversea Parts of the Empire.

The Director of Agriculture stated that, as the question of fruit cultivation was of considerable importance to Ceylon, it was desired that the Circular Despatch from the Secretary of State for the Colonies on the subject of marketing and preparing for market of fruit in the oversea parts of the Empire should be considered at that meeting. The Despatch dealt mainly with the question of getting tropical fruit to the Home markets. The Director detailed various suggestions that had been made for fostering Empire trade and Empire development. He personally thought that the Home market was a difficult one for fruit from Ceylon, even with first class

cool storage facilities. It had been definitely shown in the West Indies that the maximum commercial period on board ship for bananas was 16 days. The actual maximum period is 21 days, but such a period could not be adopted commercially. He therefore thought that, as far as plantains were concerned, the Home market would have to be ruled out. There were, however, the South European market and that of Western Australia. He thought that their first efforts should be directed towards the supply of fruit in this country, and hoped that that report would concentrate public attention on the question of fruit. He added that the Department came to a definite decision last year, that no more seedlings should be sold from its nurseries, and it was intended to bud and graft fruit plants of first class quality, and to make them available to the public. They had found that large quantities of imported plants were dying out with root disease and other troubles, indicating that the Department should make use of more of their local stocks and bud good material to them. Up to the present the Department had not done all that it should in connection with the supply of fruit plants.

The Director of Agriculture read a letter from Sir H. Marcus Fernando, suggesting that, before any organized effort could be made in Ceylon with reference to the export of fruit and vegetables, arrangements must be made with shipping companies to grant facilities for such export, as obstacles were at present placed in the way of Ceylonese shippers. Sir Marcus was of the opinion that there was a great promise for Ceylon fruit and certain vegetables for South European markets.

Mr. H. L. De Mel remarked that they had first to prove that they were capable of growing fruit of high quality suitable to the palate of different consumers. Except for pineapples, fruit cultivation had not been undertaken in Ceylon to any great extent. He thought that, if an organized attempt was made to have orchards of respectable size run under proper supervision with scientific aid, fruit growing could be established. He added that it was not correct to say that shipping facilities were difficult to obtain. He would not anticipate difficulties if supplies of fruit were available for export.

Mr. J. H. Titterington mentioned that he had treated pineapples in latex before export, and that they kept very well. This view was supported by Mr. Hew Kennedy.

The Director of Agriculture said that a certain amount of work was done in that connection in Java. He thought it had been found that if the film of rubber or latex remained intact the fruit travelled satisfactorily.

Mudaliyar Samarasinghe inquired why Ceylon fruits should not be canned, and suggested that fruit growing should be made an economic proposition and, if necessary, Government should subsidize this industry.

Sir Solomon Dias Bandaranaike remarked that where fruiting plants and pineapples with earth and roots attached had been put in a packing case, he had found that they reached England in perfect condition.

Mr. H. W. Roy Bertrand stated that the fruit grower in Ceylon did not receive sufficient encouragement. If they were to hope for anything from the fruit industry they had to steer it free of trusts which in some countries secured all the profits and left little or nothing for the grower. Some sort of co-operative arrangement ought to be devised by which the growers could be assisted.

His Excellency the Governor stated that he had noted a marked deterioration of fruit since he was last in Ceylon. It was not clear that a case had been made out for a subsidy at the expense of the State, but that is a matter to be decided by the Legislative Council. He drew attention to the fact that the principal export of the Straits Settlements during the year 1924 was 35,333 tons of pineapples. Conditions there were not in any way so good as they were in Ceylon. He believed that the fruit was exported canned, and that Ceylon ought to be able to make a profitable thing out of its fruit, if the industry were looked into and organized. Concluding his remarks, he stated that a record had been taken of the discussion, and would in due course appear in the archives of the Board of Agriculture.

His Excellency the Governor declared the meeting closed.

J. I. GNANAMUTTU,
Secretary, Board of Agriculture.
Peradeniya, March 16, 1927.

Estates Products Committee.

Minutes of the thirty-second Meeting of the Estates Products Committee of the Board of Agriculture held at the Head Office of the Department of Agriculture at 2-30 p.m. on Thursday, May 12th, 1927.

Present.—The Director of Agriculture (Chairman), the Govt. Entomologist, the Govt. Mycologist, the Govt. Agricultural Chemist, Gate Mudaliyar A. E. Rajapakse, Messrs. J. Sheridan-Patterson, A. T. Sydney Smith, R. Copland, Gordon Pyper, E. Maberley Byrde, Hew Kennedy, E. C. Villiers, J. B. Coles, J. Titterington, A. Coombe, Geo. Brown, J. W. Scott, J. Horsfall, R. G. Coombe, G. R. de Zoysa, C. A. M. de Silva, Wace de Niese, S. Paranajasingham, J. E. P. Rajapakse, H. D. Garrick, D. S. Cameron, C. E. A. Dias, A. Mahadeva, R. P. Gaddum and T. H. Holland (Secy.).

As Visitors.—Messrs. D. Kimber, M. M. Smith, J. W. Ferguson and A. N. D. A. Abeyasinghe.

Letters or telegrams regretting inability to attend were received from the Government Agent, C.P., G. W. Trevaldwyn, H. L. De Mel, W. H. Fitzpatrick and T. B. Panabokke.

The minutes of the last meeting, having been circulated to members, were taken as read and confirmed.

Agenda Item 1.—Progress Reports of the Experiment Station, Peradeniya, for the months of November and December, 1926, January and February, 1927, and March and April, 1927.

These were reviewed by the Chairman.

Referring to the November-December report, Mr. Horsfall said he was able to confirm the statement that *Indigofera endecaphylla* kept cora in control; he enquired whether the same could be said as regards couch grass.

Mr. Holland said that on the Experiment Station this could not be said to be so: couch was still coming through.

Mr. Dias enquired the size of the budded rubber on the Experiment Station.

The Chairman estimated the girth of the largest trees at about 15 inches and said it might be possible to tap this rubber next year.

Referring to the January-February report, Mr. R. G. Coombe commented on the fine show of Indigofera on Sanquhar Estate and suggested that enquiry might be made from the Superintendent of that Estate as to the results of planting the cover crops.

The Chairman said that Mr. Holland had written to the Superintendent of the estate but had not as yet received any details.

Mr. Dias made some enquiries as to the conditions under which the dwarf coconuts referred to in the report were planted.

Mr. Holland answered these queries and added that the palms were planted in grass land and had twice been submerged by floods.

Referring to the March-April report Mr. Wace de Niese enquired if *Indigofera endecaphylla* would grow under shade.

The Chairman replied that it would not thrive under heavy shade.

Agenda Item 2.—Results of Rubber Manurial Experiments on the Experiment Station, Peradeniya.

Mr. Holland reviewed this report.

Mr. de Zoysa made some enquiries as to the quantities of lime that should be applied to soils.

The Chairman said that this question would have to be decided by experiment. He then put forward the question of whether the experiments under discussion should be discontinued after the current year. He remarked that all the figures available indicated that little or no increase in yield of rubber was obtained by manuring in Ceylon.

Mr. C. E. A. Dias affirmed that he had proof to the contrary and suggested that the Chairman's statement be limited to Peradeniya.

The Chairman said that his remarks were based on figures which came from three districts: he was open to conviction in the matter.

After some discussion the meeting agreed that the question of whether or no the experiments should be continued should be discussed at the July meeting when a decision would be arrived at.

Agenda Item 3.—Effects of Change-Over Tapping on Bark Renewal.

The Chairman said that this subject had been sent in for inclusion in the agenda of the recent agricultural conference; but he had thought it more suitable for discussion by this Committee.

Mr. Holland read a portion of the summary of Departmental Bulletin No. 47—"Change-Over" Tapping, by T. Petch.

The Chairman supplemented this with information as to experiments carried out by the Rubber Research Scheme which seemed to indicate improved bark renewal as the result of changing over, though the improvement was not statistically significant.

Mr. Titterington said that in his district a half-yearly change-over was attended with considerable risk of black thread from opening new cuts in wet weather.

Mr. Sheridan-Patterson confirmed this view with regard to the Kurunegala district.

Mr. Sydney-Smith said that with present day knowledge prophylactic measures were quite adequate to guard against the dangers mentioned.

Messrs. Cameron and Dias supported Mr. Sydney-Smith's view.

Agenda Item 4.—The Treatment of Bark Diseases in Rubber.

The Chairman said that this was another subject that had been sent in for the Agricultural conference. He would ask Dr. Small to explain the present recommendations of the Department.

Dr. Small said that he would deal briefly with the two phytophthora diseases known, amongst other names, as Bark Rot and Patch Canker. As usual, prevention was better than cure. The use of 5 per cent. solutions of the water soluble kinds of Brunolinum or Agrisol applied to the tapping cut after the removal of scrap had been found effective. It was also advisable to supplement this treatment by the addition of a complete waterproof covering, and Cargillineum, applied once in 7 or 10 days, could be recommended.

The above measures might be effective in preventing Patch Canker but this question was not quite so easy since the disease might or might not appear on the tapping cut. As a curative measure the application of a 20 per cent. solution of Brunolinum or Agrisol was recommended with the addition of a light sealing or scraping in the case of a Patch Canker and cessation of tapping in the case of Bark Rot.

Mr. A. Coombe enquired whether Cargillineum could be diluted and whether coconut oil could be used for this purpose.

Dr. Small replied that dilution with some substance such as soft soap would be possible. He had not tried coconut oil.

The Chairman mentioned that the recommendation of Cargillineum emanated from results obtained by Mr. Stoughton-Harris, Mycologist to the Rubber Research Scheme.

Agenda Item 5.—Results of Buddings from No. 2 Tree, Henaratgoda.

A statement had been circulated to members giving the number of successes obtained by planters who had been supplied with bud-wood from No. 2 tree, Henaratgoda.

The Chairman said that a limited amount of bud-wood would be available from this tree in May and September and some orders had been booked. He had to thank Mr. Dias for generously supplying the Department with a portion of the bud-wood he had recently received from Java.

Mr. Dias suggested that no bud-wood should be removed from No. 2 Tree before August since August-September was a much better time for budding than May.

The Chairman replied that there was some growth which could interfere with the growth of later bud-wood if not removed in May.

Agenda Item 6.—Report on the Examination of the Bark of No. 2 Tree Henaratgoda.

A report by Mr. R. A. Taylor of the Rubber Research Scheme had been circulated to members.

In addition the Chairman furnished some information supplied by Mr. J. C. Haigh, Assistant Mycologist.

At the next meeting Mr. Haigh would submit a report on a large number of bark samples taken on the Experiment Station, Peradeniya, and at Henaratgoda Gardens.

Agenda Item 7.—Research Work on Coconuts and Cinnamon.

Mr. C. A. M. de Silva suggested that pending the initiation of a Coconut Research Scheme the Department should assist by inaugurating co-operative experiments on Estates.

Mr. de Zoysa enquired from the Chairman what was the position as regards the representations made at the recent agricultural conference in the matter of coconut research.

The Chairman replied that the question had been now referred back to the sub-committee of the Board of Agriculture which had formulated proposals for the extension of the work of the Agricultural Department. He promised at the next meeting to report the action taken by this sub-committee.

Agenda Item 8.—The Treatment of *Indigofera endecaphylla* in the Experiment Station Tea.

Mr. Brown suggested that as it had been shown that the cover crop had not depressed the yield of tea the digging in of the cover crop was now advisable. He considered that the agricultural treatment of cover crops of great importance.

Mr. Horsfall mentioned the good results he had obtained by forking through Indigofera and pushing in the creeper behind the fork.

Mr. Sydney-Smith dwelt on the possibility that many estates might not have the labour for cutting and burying such a cover crop even though the actual cost per acre was comparatively small.

The Chairman said that until recently he had considered that no increase in the nitrogen content of the soil was likely to be expected by the mere presence of a leguminous crop. He had recently read evidence in England, however, to show that the presence of a crop of clover had resulted in an increase in the nitrogen content of the soil although the crop was not dug in. Nevertheless the increase of the supply of humus in the soil should be one of the principal objects in tropical agriculture and he advocated periodically burying a cover crop either by forking or trenching whenever such a procedure was possible.

Mr. Holland pointed out that on the Experiment Station the cover crop was not being left uncut. Alternate rows had been cut in March in order to allow the application of artificial manures. The remaining rows would be cut after pruning in October-November for the application of the pruning mixture. The principal object of the present experiment was to ascertain the effect of the presence of the cover crop upon the yield of tea and for this purpose it was essential that, except for the presence of the cover crop, the same conditions should be maintained as formerly existed.

He did not consider the question of the effect on yield was by any means settled yet and considered the experiment should be continued as planned for a few years.

Agenda Item 9.—Travelling Expenses of Members.

Mr. R. G. Coombe said that the present train service, good though it was, did not enable members coming from Uva to attend meetings of the Estates Products Committee without considerable loss of time. He asked if it would not be possible for members to be paid the equivalent value of the Railway warrants at present issued to them.

Messrs. E. C. Villiers and A. Coombe supported Mr. R. G. Coombe's contention as regards the Kelani Valley and Kalutara Districts.

A resolution was passed to the effect that Government should be asked that a sum equivalent to the value of the railway warrants now supplied should be granted to members in lieu of such warrants.

Agenda Item 10.—The Handling of Young Tea.

Mr. J. Horsfall gave a most interesting account, illustrated by diagrams, of his experiments in handling young tea. He had evolved a method of which the essential point was that no red wood was cut in the early stages of the history of the bush. Considerable success had been met with and vacancies had been much reduced.

Mr. R. G. Coombe said he had been very much impressed with the cover formed in a 30-acre clearing of Mr. Horsfall's which had been treated in the method described.

Mr. Cameron enquired the cost of the method.

Mr. Horsfall replied that the cost was now about Re. 1·00 per acre.

The work was all done by women with pocket knives. Considerable patience and time had of course been required at first to train the coolies.

Mr. Scott enquired how this method could be adopted if stumps were planted.

Mr. Horsfall replied that it was only possible when seed at stake or small plants were planted.

The Chairman said he had seen and been much impressed by the work done by Mr. Horsfall. The spread of the bushes was very good and must result in a diminution of soil erosion. In Assam great pains were taken to encourage the spread of the bushes with this object. He proposed a hearty vote of thanks to Mr. Horsfall for explaining his methods.

This was carried.

Mr. Pyper suggested that Mr. Horsfall should publish a description of his methods with diagrams in the *Tropical Agriculturist*.

Agenda Item 11.—Provision from Rubber Restriction Funds for Budding and Seed Selection Work.

Mr. R. G. Coombe asked if any information was available as to the resolutions forwarded to Government in this connection in November, 1926.

The Chairman said that the resolutions had been submitted to Government within two days of their having been passed. He had written requesting that a reply be furnished before the present meeting but no reply had been received to this request.

Mr. Dias said that he did not think the funds asked for would be granted and thought that the introduction of an ordinance to levy a cess would be necessary.

The Chairman asked if it was the desire of the meeting that he should again write to Government asking for a reply at the earliest possible moment and that the subject be again placed on the agenda at the next meeting.

This course was agreed to.

T. H. HOLLAND,
Secretary,

Estates Products Committee,
Peradeniya.

Kandy District Agricultural Committee.

Minutes of a meeting of the Kandy District Agricultural Committee held at the Kandy Kachcheri on the 17th March, 1927, at 2 p.m.

Present.—W. L. Kindersley, Esq., in the chair, Messrs. J. C. Ratwatte Disawa, A. Godamune, T. B. Panabokke, A. B. Talgodapitiya, T. B. Mampitiya, Ratemahatmaya, Yatinuwara; H. D. Keppitipola, Ratemahatmaya, Uda Palata; W. R. Hancock, H. Nugawela, Ratemahatmaya, Harispattu; N. K. Jardine, F. Burnett, Divisional Agricultural Officer, Central and Mr. H. A. Webb.

1. Minutes of previous meeting were confirmed.

2. Mr. F. Burnett, D.A.O., C.D., described working of pure line paddy and the results of the paddy experiments at Katugastota. Messrs. A Godamune and T. B. Mampitiya each undertook to try ½ acre in cultivation of pure line paddy.

3. Mr. F. Burnett spoke at length on the losses of paddy through present methods of harvesting, threshing, etc. Loss ascribed to (1) loss by falling grains at reaping, (2) loss in carrying to threshing floor, (3) loss by poor threshing, (4) paddy bug.

Mr. N. K. Jardine too spoke on the question and added rats, instancing burrows with 7 or 10 pounds of dry grains.

The following suggestions were made:-

(1) To get Vel Muladeniyas to ripen crop at one time
(2) to carry grain in mats
(3) to inquire if a simple but better threshing machine than the buffalo can be devised
(4) to inquire methods used in Spain and Italy
(5) to fix periods so as to have intervals during which paddy bug would get no food.

(6) as regards rats the Committee decided to suggest to the Director of Agriculture that Mr. Jardine be asked to continue his investigations and if possible devise a method of eliminating the rat pest.

4. Discussed the question of Agricultural Shows and Competitions and decided to hold vegetable garden competitions for Uda Palata and Uda Bulatgama.

5. and 6. Discussed the question re Agricultural Associations and results of items brought before them. Mr. F. Burnett undertook to start an Association near Katugastota to see the work of experimental plots.

7. Discussed the damage to Ela bunds by taking water and by cutting bunds.

The Government Agent has directed the Ratemahatmayas of the Kandy District to inspect and apply the rules against these. The Irrigation Sub-Inspector to state cost of cement sluices which leads to the field.

Recommended that a reservation of two feet from foot of bank should be prohibited from cultivation.

Trincomalie District Food Production Committee.

Minutes of a meeting of the District Food Production Committee, Trincomalie, held at the Kachcheri on 19th February, 1927, at 10 a.m.

Present.—Mr. B. G. de Glanville (Chairman), Mr. W. G. Vallipuram, (Secretary), Messrs. M. C. Pietersz, Divisional Forest Officer, E.D. (N.), W. T. I. Alagaratnam, S.D.O., K. Somasunderam, Town Vanniyah, M. Rasiah, Vanniah, Kaddukulam Pattu, V. Ramanathan, Agricultural Instructor and Mr. S. M. Vappu Raja Udaiyar, Koddiyar.

1. Minutes of meeting held on 2-10-26 were read and confirmed.

2. The possibility of holding an agricultural and industrial show this year was discussed and it was resolved not to hold a show this year as there is no promise of its being a success.

Tea Research Institute.

Minutes of the Sixth Meeting of the Board of the Tea Research Institute of Ceylon, held in the Victoria Commemoration Buildings, Kandy, at 1 p.m. on Thursday the 24th February, 1927.

Present.—Mr. John Horsfall (Acting Chairman), The Hon'ble Mr. J. W. Oldfield, Mr. T. B. Panabokke, Messrs. D. S. Cameron, H. Hopwood and A. W. L. Turner (Secretary); the Director (Mr. T. Petch) was present by invitation.

Notice calling the Meeting was read.

Minutes of the Fifth Meeting of the Board which was held in the Chamber of Commerce, Colombo, on November the 24th, 1926, were confirmed.

Letters and telegrams regretting inability to be present at the Meeting were received from the following Members:—The Director of Agriculture, Col. T. G. Jayawardene, Messrs. George Brown and J. D. Finch Noyes.

The Chairman said he was sorry that the date chosen for the Meeting was inconvenient for several Members of the Board. He had selected that date because it was the only possible day on which Mr. R. G. Coombe would have been able to attend if the vessel on which he was returning to Ceylon had been punctual. The fact that the vessel was thirty-six hours late in arriving had upset his calculations.

Annual Report.

The Chairman announced that the Annual Report for 1926 had been circulated to and approved by all Members of the Board, and a copy of the portion dealing with the Administration of the Board had been sent to the Ceylon Government in accordance with Section 13 of Ordinance No. 12 of 1925. He asked for the Board's opinion on the subject of printing and distributing the Report.

It was finally decided that estimates for printing 2,000 copies of the Report, including the library list should be obtained from the leading printing firms in the Island and also from Messrs. Walker & Greig, Lindula. The size to be 9½ x 6 inches and the title, " Bulletin No. 1 of 1927." A free copy is to be sent to all registered estates and to all those to whom copies of the Minutes are sent. The Secretary was instructed to ascertain how many copies would be required by the Ceylon Estates Proprietary Association.

Purchase of an Estate.

The Board considered two estates and had to reject four others for one cause or another.

Scheme for Purchasing an Estate.

A letter from the Ceylon Association in London dated January 6th was read and certain views collected by the Chairman, Ceylon Estates Proprietary Association were considered.

The Secretary was instructed to forward the draft scheme agreed upon, to the Ceylon Association in London and the Ceylon Estates Proprietary Association for their remarks.

Finance.

The Chairman explained that the Auditor was at present busy with the books and the final accounts for 1926 and those for January, 1927, would be prepared as soon as possible.

Arising from a question by the Secretary with reference to a few outstanding accounts for 1926, it was decided that, if the Auditor would agree, these should be included in 1927, or failing that a supplementary account should be drawn up.

Publications.

The Chairman stated that only 64 estates had been registered as wanting to receive the Institute's publications. The advertisement had appeared in three issues of the principal morning and evening English Papers and in two Vernacular Papers and would appear in the February issue of the *Tropical Agriculturist*.

The Board considered this was a very poor result and, on the suggestion of the Chairman, the Secretary was instructed to write to all the chief Agency Companies on the subject.

The Chairman then asked for the Board's opinion with regard to publications being sent to persons and firms who though connected with the Tea trade, did not actually pay the cess.

It was decided that, after satisfactory replies from the Chamber of Commerce such persons and Firms should be registered and that in addition, all publications should be sent to those to whom the Minutes of the Meetings were already sent.

The Chairman then asked Mr. T. B. Panabokke for his advice on the best way for the Institute to get in contact with the small holder.

Mr. Panabokke said that this could be done through Government Agents, Ratemahatmayas and Headmen, but he pointed out the futility of sending leaflets, etc., to a large proportion of the small holders. He added that he intended to bring the subject forward when the Institute was in thorough working order and to suggest that arrangements should be made whereby the small holder could receive verbal instruction.

The Chairman said that one of the original schemes contained a proposal that Travelling Inspectors should be appointed and he considered it very likely that this would be done at a later date. It was further pointed out that sub-stations would be established in due course.

The Chairman then asked the Director for his views on the subject of Publications.

The Director said that he had received a letter from the Secretary asking whether the Staff of the Institute were prepared to send Quarterly contributions for publication in the *Tropical Agriculturist*.

He said that he did not consider that at the present time Members of the Staff were in a position to make regular contributions to any journal. In general they had only just begun the investigations of the problems on which they are engaged and some time must elapse before they are able to publish results. At the same time in order to keep the Planters in touch with the Institute he said that he is quite prepared to issue to the Press, including the *Tropical Agriculturist*, communiques dealing with points of interest to tea planters, as and when they may arise.

As regards the future publications of the Institute he submitted the following details:—

(1) The Scientific Department of the Indian Tea Association publishes a series of Bulletins and a Quarterly Journal. Subscription to the Scientific Department does not entitle the subscribers to free copies of these publications.

(2) The Proefstation voor Thee, Java, publishes Bulletins and a Quarterly journal although the Proefstation is maintained by voluntary subscriptions both these publications have to be purchased by subscribers.

(3) The Tea Experiment Station, Japan, publishes Bulletins and a Journal, but I do not know on what terms.

(4) The Rubber Research Institute of Malaya intends to issue its own publications.

(5) The Rubber Research Scheme of Ceylon is not a parallel case, as the greater part of its funds are contributed by Government from general revenue. Subscribers receive the Rubber Growers' Association Bulletin monthly.

He said that he considered the Tea Research Institute should publish:—

(*a*) Bulletins which should be sold, as in India and Java, not issued free, except in special cases where it may be thought advisable.

(*b*) Leaflets, containing short communications on practical points. These might be published in English and in Sinhalese, and issued free. Permission might be sought for free postage of these.

(*c*) Annual Reports.—These should be published in the Bulletin series, and issued free.

(*d*) Press Communiques on points of general interest, or which it is desirable to bring to the notice of the public immediately.

(*e*) A Quarterly Journal.—This cannot be undertaken until more men are available and work is being carried on under more settled conditions. The Journal would, of course, be sold.

He said that opinion in the Tea Districts was strongly in favour of the Institute having its own publications. Prominent Planters had informed him that they wanted all the information on Tea in a periodical which dealt with Tea only.

The Nuwara Eliya Planters' Association passed a resolution at their last Meeting, recommending that the Tea Research Institute should run its own publications. The prestige of the Institute depended on this question.

The Chairman said that he did not consider that the Institute could undertake to publish a Journal at present. He suggested that all leaflets should be free and perhaps bulletins also.

On the suggestion of the Hon. Mr. J. W. Oldfield it was finally decided that:—

(*a*) All leaflets should be free.

(*b*) One copy of each Bulletin should be issued free to all those in the register and that if additional copies were asked for they could be supplied "on payment."

Circulation of Papers.

The Secretary was instructed to place on record that the following papers had been circulated to all Members of the Board.

(*a*) The Director's reports on two estates, in both cases the report was unfavourable.

(*b*) **Agricultural Conference.** — The Board had agreed that the Institute should co-operate with the Department of Agriculture at the March Conference. The Director had arranged for Dr. C. H. Gadd to read a paper on "Some Diseases of Tea" and Mr. S. Stuart Light a paper on "Tea Mites."

Staff.

(*a*) **Senior Chemist.**—The Chairman stated that in accordance with the instructions of the Board given at their last Meeting, the Secretary had written to the Chairman of the Ceylon Association in London asking him to interview Mr. T. Eden. No reply had yet been received.

(*b*) **Dr. C. H. Gadd's Agreement.**—The Board gave the necessary authority for affixing the seal of the Institute to the Agreement.

Buildings and Laboratories.

The Chairman said he had sent a Memorandum on this subject to all Members of the Board and the following remarks had been received:—

(*a*) "Taking everything into consideration I favour the idea of one building housing all branches as in Java. Sites are difficult to obtain on the average estate and cutting out Tea is to be avoided as much as possible. Designs and plans should be called for."

(Signed) J. D. Finch Noyes.

(*b*) No. A. 500,
Department of Agriculture,
Peradeniya,
25th January, 1927.

Dear Sir,

I have the honour to acknowledge the receipt of the Acting Chairman's Memorandum of January 24th, and in reply thereto to state that I agree to the principle of one building for the laboratories, but I do not consider that it should be more than two storeys high. It should be designed so that it can later on be extended when necessary. I would favour a separate lecture room and this might be attached to the proposed rest-house accommodation. It will not be necessary to build this until the laboratories have been completed.

Yours faithfully,

(Signed) F. A. Stockdale,
Director of Agriculture.

The Secretary,
Tea Research Institute of Ceylon,
Kandy.

The Director said he preferred one-storey detached buildings but this could not be decided till an estate had been purchased.

After a short discussion it was agreed that it was too early to arrive at a definite decision. The Secretary was instructed to endeavour to obtain designs of laboratories suitable for a temperate climate by approaching Scientific Institutions in other parts of the Empire.

Any Other Business.

(*a*) A letter from Mr. M. L. Wilkins resigning his seat on the Board owing to ill-health was read.

The Board accepted Mr. Wilkins' resignation with regret.

(*b*) A letter from Mr. R. G. Coombe accepting the Chairmanship of the Board was read.

Insurance of the Staff.—In continuation of some remarks made by Mr. W. Coombe after the last Meeting of the Board, the Director asked if the Board would consider the question of insurance.

After a short discussion the Director was asked to draw up a memorandum on the subject and the Secretary was instructed to ascertain if the Ceylon Planters' Provident Society would permit members of the Staff to join the Society.

The Meeting closed with a vote of thanks to the Chair.

A. W. L. TURNER,
Secretary.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st MARCH, 1927.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st. 1927	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	30	30	5	...	25	...
	Anthrax	...	...	...	...	...	...
	Rabies. (Dogs).	...	...	...	...		4
Colombo Municipality *	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	3	2	...	...	..	3
	Do (Bull)	1	...	...	...	...	1
Cattle Quarantine Station *	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax		1	...	12	.	...
Central	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	1	1	1	...	...	..
	Anthrax	1	...	...	1	...	...
	Rabies (Dogs)	9	...	...	7		2
Southern	Rinderpest	32	...	8	23	...	1
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	..	...	...
Northern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	8	8	8	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	1	...	...	...		1
Eastern	Rinderpest						
	Foot-and-mouth disease	F R	E E				
	Anthrax						
North-Western	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	1	1		...	..	1
North-Central	Rinderpest						
	Foot-and-mouth disease	F R	E E				
	Anthrax						
Uva	Rinderpest						
	Foot-and-mouth disease	F R	E E				
	Anthrax						
Sabaragamuwa	Rinderpest						
	Foot-and-mouth disease	F R	E E				
	Anthrax						

* Till the end of February. Figures for March not yet to hand.

Colombo, 7th April, 1927.

G. W. STURGESS,
Government Veterinary Surgeon.

METEOROLOGICAL

MARCH, 1927.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud 0=clear 10=overcast	Mean Wind Direction during Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	81·0	—0·4	83	7·7	Var:	88	5·91	22	+ 1·19
Puttalam	81·4	+1 2	75	4·5	ENE	121	2·08	11	— 0·37
Mannar	82·5	—0·5	80	6·8	E	143	3·74	11	+ 2·27
Jaffna	83·3	+0·5	75	4·3	SE	118	1·50	4	+ 0·28
Trincomalee	82·0	—0·6	80	6·0	E	145	7·36	14	+ 5·69
Batticaloa	80·4	0·4	82	6·4	N	150	17·64	15	+ 14·64
Hambantota	80·0	—0·4	84	5·8	ENE	158	10·16	12	+ 7·79
Galle	80·8	—0·3	84	7·3	Var:	138	10·73	13	+ 6·17
Ratnapura	81·8	-0·4	78	6·6	—	—	16·61	19	+ 7·61
Anu'pura	80·2	—1·8	76	7·2	—	—	6·71	13	— 3·92
Kurunegala	81·4	—1·4	78	7·5	—	—	10·98	20	+ 5·89
Kandy	77·6	—0·8	77	7·8	—		5·76	18	+ 1·76
Badulla	73·3	—0·1	85	7·0	—	—	10·63	20	— 6
Diyatalawa	67·5	—0·2	80	7·4		—	7·36	21	+ 3·1
Hakgala	62·6	+2·3	84	6·1	—		10·97	20	+ 5 56
N.' Eliya	60·6	+1·4	77	7·4	—	—	6·04	19	+ 2·63

The rainfall of March was considerably above average throughout the greater part of the island. This was particularly the case during the first three weeks of the month. From the 22nd to the 26th was a comparatively dry period, while in the last few days there was further rain, accompanied by the unusually early appearance of a mild pressure gradient from the west or south-west.

The excess was particularly marked on the east side, where totals that were more than ten inches above their average were common.

The highest figures recorded in a single day were on the 14th, and included 8·57 inches at Sacumbe and over 7 inches at Nalanda, besides several figures over 5 inches. Other falls of over 5 inches were on the 4th at Tirrukovil, Walton (Monaragala) and Yala, on the 11th at Rayigam, 19th at Maho, and 28th at Keragala.

The stations that failed to reach average included a few in the western halves of the Jaffna Peninsula and of the Southern Province, and one or two in the south of the North-Western Province, but in none of these cases was the area in deficit a large one.

A. J. BAMFORD,
Supdt. Observatory

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 30th APRIL, 1927.

Province, &c.	Disease	No of Cases up to date since Jan. 1st, 1927	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	208	178	87	...	121	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	5	1	...	...	...	5
Colombo Municipality*	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	23	23	21	...	1	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	3	...	...	...	...	3
	Do (Bull)	1	...	...	...	...	1
	Do (Horse)	1	...	...	...	...	1
Cattle Quarantine Station*	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	22	22	18	...	4	...
	Anthrax	12	...	...	12	...	...
Central	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	11	10	1	...	0	...
	Anthrax	2	1	...	2	...	...
	Rabies (Dogs)	13	4	...	10	...	3
Southern	Rinderpest	32	...	8	23	...	1
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...		...	...	...
Northern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	8	...	8	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	1	...	...	...	...	1
Eastern	Rinderpest						
	Foot-and-mouth disease	F R E E					
	Anthrax						
North-Western	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...		...	...	...	...
	Rabies (Dogs)	1	...	...	...	...	1
North-Central	Rinderpest						
	Foot-and-mouth disease	F R E E					
	Anthrax						
Uva	Rinderpest						
	Foot-and mouth disease	F R E E					
	Anthrax						
Sabaragamuwa	Rinderpest						
	Foot-and-mouth disease	F R E E					
	Anthrax						

* Figures for March. April figures not yet to hand.

Colombo 4th May, 1927.

G. W. STURGESS,
Government Veterinary Surgeon.

METEOROLOGICAL

APRIL, 1927.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud 0=clear 10=overcast	Mean Wind Direction During Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	82·2	−0·4	81	6·4	SW	92	11·00	15	+ 3·06
Puttalam	82·6	−0·2	78	4·2	SW	137	7·18	9	+ 1·88
Mannar	84·6	−0·8	78	5·7	S	149	3·54	10	+ 0·73
Jaffna	84·6	−1·2	75	4·8	SSW	229	5·64	10	+ 3·75
Trincomalee	84·8	−0·4	74	4·3	S	132	4·21	7	+ 2·29
Batticaloa	83·4	+0·2	78	4·9	E	144	4·02	7	+ 2·19
Hambantota	82·2	+0·3	82	4·2	SW	178	2·41	6	− 0·86
Galle	82·0	+0·2	83	5·3	WNW	163	5·53	14	− 4·25
Ratnapura	83·0	+0·6	78	5·8	—	—	10·48	16	− 1·78
Anu'pura	82·6	−1·1	76	5·8	—	—	8·84	12	+ 1·17
Kurunegala	83·0	−0·4	76	6·2	—	—	12·15	12	+ 2·73
Kandy	79·4	+0·4	75	6·4	—	—	5·91	9	− 0·75
Badulla	74·6	−0·9	82	5·6	—	—	6·22	12	− 1·08
Diyatalawa	69·2	−0·3	74	4·8	—	—	6·54	13	+ 0·98
Hakgala	64·2	+1·8	78	5·1	—	—	5·84	12	− 0·17
N'Eliya	59·4	−1·1	76	5·9	—	—	4·08	9	− 1·51

There were a few vigorous local thundershowers during the first week of April, followed by a decidedly dry period from the 6th to the 18th, after which the thunderstorms again came into action, while during the last few days of the month there was more general rain, owing to a depression which had begun to form off the east coast.

As a natural result of so large a proportion of the rain having fallen in the form of thunderstorms, the distribution over the island was uneven. A very rough summary can be given by saying that the coastal areas were above average, and the inland ones below, while this may be amplified by adding that the biggest offsets above average were near the west coast between Colombo and Puttalam, and that the area above average extended inland to include most of the North-Western Province and the Kelani Valley.

The highest totals for the month were at Franklands (Veyangoda), 22·8 inches, and Padupola 21·9 inches, while Henaratgoda and Dunedin were both over 20 inches.

The heaviest figures for 24 hours were recorded on the 30th and included Henaratgoda, 10·50 inches, Ragama 10·13, Franklands (Veyangoda) 8·25, Avissawella 8·10.

A. J. BAMFORD
Supdt. Observatory

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st MAY, 1927.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st. 1927	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	411	203	316	2	93	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs).	5		...			5
Colombo Municipality *	Rinderpest	...				...	...
	Foot-and-mouth disease	78		5		17	1
	Anthrax	...			...	...	...
	Rabies	9*			...	...	9
Cattle Quarantine Station ‡	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	28	6	25	...	3	...
	Anthrax	12	...		12		...
Central	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	11	...	11	...	...	...
	Anthrax	2	...	...	2	...	...
	Rabies (Dogs)	14	1	...	10	...	4
Southern	Rinderpest	32	...	8	23	...	1
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
Northern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	8	...	8	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	1	...	...	...	...	1
Eastern	Rinderpest						
	Foot-and-mouth disease	95	95	80	15	...	...
	Anthrax						
North-Western	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	1	...	...	...	...	1
North-Central	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	127	127	122	5	...	...
	Anthrax	...	...	...	...	...	...
	Haemorrhagic Septicaemia.	6	6	...	5	1	...
Uva	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
	Piroplasmosis	12	12	...	12	...	...
	Rabies. (Dogs).	1	1	...	1	...	...
Sabaragamuwa	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	17	17	2	...	15	...
	Anthrax	...	...	...	...	...	...

* 1 case in a Bull and 1 in a Horse

‡ Till the end of April. Figures for May not yet to hand.

G. W. STURGESS,
Government Veterinary Surgeon.

Colombo, 8th June, 1927.

METEOROLOGICAL

MAY, 1927.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud 0=clear 10=overcast	Mean Wind Direction during Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	82·1	—0·5	82	9·0	SW	152	22·65	22	+ 9·27
Puttalam	82·2	—1·0	82	5·4	SW	185	3·10	18	- 0·41
Mannar	84·6	—1·2	76	7·2	SSW	206	3·68	5	+ 1·68
Jaffna	83·7	—1·5	82	4·9	SW	345	3·28	4	+ 1·59
Trincomalee	84·4	—1·8	84	6·2	WSW	251	5·06	9	+ 2·62
Batticaloa	84·0	—0·6	75	6·2	Var:	129	1·89	6	+ 0·11
Hambantota	81·4	—0·8	86	6·2	WSW	249	5·34	16	+ 2·18
Galle	81·0	—0·8	84	7·7	WNW	260	20·09	26	+ 8·68
Ratnapura	81·0	—0·8	84	7·4	—	—	38·98	26	+ 20·92
Anu'pura	81·8	—1·7	80	7·0	—	—	3·03	9	- 0·33
Kurunegala	81·4	—1·4	81	7·8	—	—	8·85	17	+ 2·21
Kandy	78·2	—0·5	80	8·0	—	—	11·43	18	+ 5·74
Badulla	75·0	—0·4	72	6·6	—	—	2·62	10	— 1·90
Diyatalawa	70·4	—0·3	76	7·2	—	—	8·31	14	+ 3·17
Hakgala	65·2	+1·4	81	6·0	—	—	9·96	22	+ 2·97
N.' Eliya	62·2	+0·4	86	7·8	—	—	13·90	19	+ 7·13

The rainfall of May was decidedly above average in the South-west quarter of the island, i.e, in the area in which the averages for May are highest.

A depression that had caused heavy rain on April 30th continued to affect Ceylon rainfall in the first few days of May and emphasised the fact of its depressional nature by the way in which the area of heaviest rainfall varied. Thus on the 1st the highest figures were in the Kelani Valley-Rayigam 12·71, Eheliyagoda 10·44. Marambekande 10·35, on the 3rd the North and East got most attention with Kilinochchi 7·50 and Amparai 7·20 though Galle had 6·31. On the 4th the activity in the extreme South-west moved northward and gave Kanana (Bentota) 11·20, Geekiyanakanda 10·01, Sirikandura 8·92.

From the 6th to the 16th there was very little rain but on the 16th there was hail at Diyatalawa and from that date onwards rain of a more monsoonal type was in evidence in the Low-country of the South-west of the island and within a few days both spread inland and developed in intensity. The highest figures were on the 26th and 29th and included Kitulgala 9·24 on the former and Maskeliya 7·42 on the latter.

The highest totals for the month were Gendagala (Kukul Korale) 59·94, Rayigam (Padukka) 51·91 or 31·47 above its own average and Hallayen (Ratnapura) 49·71 or 30·8 above its own average.

A. J. BAMFORD,
Supdt. Observatory.